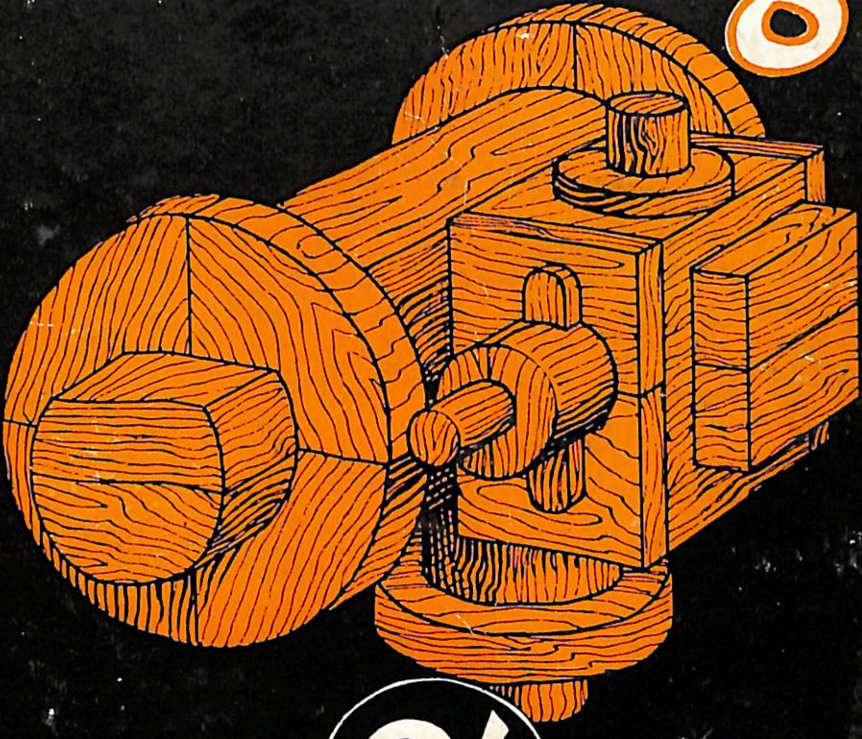
Pattern Making



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PERCIVAL MARSHALL & Co. Ltd. LONDON

PATTERN MAKING

Describing the processes of making a simple mould, the general practice of pattern making and typical examples of light and heavy work.

BY

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PREFACE

The pattern shop is one of the most important departments in an ironfoundry or engineering works. It is the starting point for the production of the many important and varied castings which are required in the building of an engine or machine. The pattern maker produces a pattern or model in wood to enable the moulder in the foundry to form the mould into which the molten metal is to be poured. The arts of pattern making and moulding are very closely related. However good a craftsman in wood the pattern maker may be, his skill in using tools and material must be supplemented by an intimate knowledge of the processes of the foundry, so that the patterns he makes may not only be easily moulded, but may be readily withdrawn from the sand. For this reason the opening chapter of the book explains the process of moulding and making castings. With this knowledge in mind, the reader will be the better able to follow the reasons for the various methods adopted in the making of both patterns and core-boxes.

This book does not pretend to be more than an introduction to a very skilled craft, but every young engineer and draughtsman should have a general knowledge of the work done in the pattern shop and foundry, and it is hoped that the knowledge imparted may repay a careful study. The book may also, perhaps, prove of service for the small general engineering shop and the home workshop, where patterns for repairs and special castings have often to be made, to be sent away to a foundry for casting. The foundryman will respect a pattern which has a professional touch about it, and will certainly treat it with more care and more interest than if it added to his daily worries by reason of its technical imperfections.

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CHAPTER I

HOW CASTINGS ARE MADE

THE process of manufacturing castings, known as Founding, is a very old one, and dates from the times of the ancient Britons and early Romans. We are told by archaeologists that the early Chinese and Egyptians were familar with the art of pouring molten metal into a mould, but however skilful these peoples were, the methods used today must differ considerably from those of far-off times.

As far as this country is concerned, founding became a practical proposition in the fifteenth century. In other parts of Europe blast furnaces were operated rather earlier, and since then the foundry has played an ever increasingly important part in the world of engineering.

The primary requirements to produce a casting are :—

A pattern to reproduce in the desired metal.

A mould or impression to receive the fluid metal.

A vessel capable of holding molten metal.

A source of heat sufficient to liquefy the metal.

As a general rule patterns are made of wood and the mould of sand. The latter is rammed or packed around the pattern, so that when the pattern is withdrawn from the sand a space is left which is filled with the molten metal. An ordinary sand mould, once used, cannot be used again, a fresh mould having to be prepared for each separate casting. There are, however, some preparations which can be used for a number of castings providing their shape will enable them to leave the mould without causing its destruction.

Castings are made under a wide range of conditions. Tiny shops—they can scarcely be called foundries—produce excellent castings, though of limited size, often with only the simplest of plant, worked by only two men. Jobbing foundries are generally able to make castings up to five tons or so, and are numerous throughout the land. Such works usually possess a machine shop in addition to a pattern shop. Finally there are the large works found chiefly in the industrial centres where castings of almost any size and description are turned out. Castings weighing 50 tons and over are by no means uncommon.

The amateur or experimenter who would like to try his hand at making castings may do so with extremely simple apparatus and with the certainty of obtaining satisfactory results, once the process is understood. It is, indeed, rather surprising that although so many possess a high degree of skill in the manipulation of machine tools, and a knowledge of metal work, few understand, and fewer undertake, the construction of patterns or manufacture of castings.

The size of a casting that may be produced is governed by the size of the moulding box and the amount of metal it is possible to melt and handle. Without the use of hoists, cranes, or some form of tackle on an overhead runway, 2 cwt. is about the limit for manhandling. Metal for castings of this weight is often transported by two or three men in a "shank"; up to 56 pounds can be easily carried in a hand ladle by one man.

When only small quantities of metal are required a crucible may be used, graphite or plumbago, in which case the metal is both melted in and poured from the crucible.

The metals in which castings are made are numerous; lead, aluminium, brass, gun-metal, phosphor-bronze and cast iron are the simplest. Malleable-iron and cast steel present certain difficulties, and are dealt with by firms specialising in their production.

For the melting of cast iron a cupola is generally used, the metal being "tapped out" into ladles and carried to the moulds, but small quantities may be melted quite satisfactorily in a crucible. For the remaining metals mentioned in the previous paragraph, excluding cast steel and malleable-iron, crucibles are in almost universal use for small quantities. Lead, because of its low melting point, may be melted in an iron or steel vessel without any lining.

Metal for melting is obtained from various sources. For cast iron, " pig " is obtained from the blast furnaces and is supplied in any number of qualities to suit particular requirements. Non-ferrous metals, that is metals other than iron and steel, are purchased in the form of ingots, and here again the composition of metal for a special purpose may readily be obtained. Most foundries use a considerable amount of " scrap," metal which has previously existed in the form of some casting or other ; if only small quantities are required, scrap, which is easily obtained from any merchant, is probably the simplest form of supply. The analysis of scrap metal is always a matter for speculation.

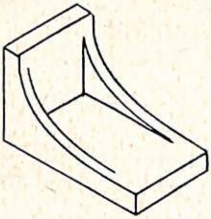
Preparing a mould

Before passing to a detailed consideration of the various processes it would be well to gain a general idea of the whole art of making castings ; firstly, then, the pattern. As already stated, this is usually made of wood and while a good finish is most desirable, particularly if more than one casting is to be made from it, certain " one-off " jobs need only be quite roughly made. One essential, in any pattern, is that it shall be removable from the sand mould and, for this reason, most patterns are tapered slightly. Externally the pattern is similar to the finished casting, but frequently carries " prints." These are projections from the pattern, which, leaving a corresponding impression in the mould, locate the cores used to form holes and recesses in the casting. As almost all castings shrink a little on cooling the pattern is made slightly larger than the finished article.

The mould, made of sand sufficiently moist to retain the shape imparted to it by the pattern, is rammed round the pattern, the whole being surrounded by the moulding box. Boxes are usually in two parts, an upper and a lower, known respectively as the "cope" and the "drag." These parts are located together by means of two pins on one half which enter two corresponding holes in projecting lugs, on the other. If the pattern has one face perfectly flat, the face of the sand in the top half is also flat, and through it are two holes communicating with the mould, one for pouring in the molten metal and the other for the metal to rise up when the mould is full—the runner and the riser. In the case of a pattern that has no flat side, part of the impression is made in the upper and part in the lower boxes. The division of sand between the two halves of the moulding box is known as the joint.

Before removing the pattern from the mould, it is advisable to moisten the sand slightly round the pattern so that when it is withdrawn the sharp edges of sand are not disturbed. As a further help towards a clean "draw" the pattern is "rapped," that is moved slightly from side to side and from end to end before attempting to lift it from the sand; further gentle rapping as the pattern is withdrawn will assist in preventing adhesion to the mould. Any portion of the mould that may have accidentally been lossened must be carefully pressed back into place with a suitable tool and the whole mould made smooth and clean before fitting the cores—if any—and closing the box. Except when making the smallest of castings the top half of the box must be weighted or clamped down to prevent it lifting when pouring in the metal; otherwise the metal would escape at the joint. It is always as well to have the mould quite ready to receive the metal before starting to melt. By adopting this method any unforeseen delay in finishing a mould need not result in overheating or maintaining the metal in a liquid state for a long time, both of which are detrimental to the quality of the metal (particularly aluminium and brass) to say nothing of the waste of fuel. In large foundries, of course, molten metal is always " on tap " as moulds are constantly being finished ready for casting, but even in such works it will often be found that metal is only available between say 10 and 12 o'clock in the morning and 3 and 5 o'clock in the afternoon.

After casting, sufficient time must be allowed for the metal to solidify before opening the mould, and after removal the casting requires cleaning or " fettling " to remove the burnt sand adhering to it. Usually this is done by brushing with a wire brush, also the runner and riser must be sawn off ; in the case of cast iron they are usually knocked off, but care is necessary when doing this. Thousands of otherwise sound castings have been spoilt by " breaking in "—that is to say, by a part of the actual casting being broken off with the runner or riser, even when experienced men are on the job. Grinding wheels are used to dress castings, being particularly useful in removing the jagged edges of metal which frequently occur at the joint of the mould, called " flash." Heavy castings are dressed with pneumatic chisels, or hammer and chisel, and finished off with portable grinders.



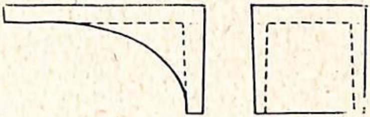


Fig. 1 (left).—Casting
Fig. 2.—Pattern—taper exaggerated

Sequence of operations

Let us now consider, with the aid of sketches, the sequence of operations necessary to make a casting, and for this purpose let us suppose that an angle plate weighing say 12 lb. is to be made. Fig. 1 shows the casting with two stiffening brackets ; the pattern is built up from four separate pieces of wood, the necessary taper on the various surfaces, much exaggerated, being shown in Fig. 2. This pattern is placed, largest face downwards, on a " turning-over board " and the bottom half of a moulding box placed over it with an approximately equal distance on all sides of the pattern (Fig. 3). Having sprinkled just a trace of parting powder over the pattern and the board, facing sand is sieved into the box until the pattern is covered. To save excessive sieving this fine sand may be tucked up to the sides of the pattern by hand. The box is now filled with more sand, taken from the foundry floor, which, although not necessarily sieved should have been passed through a $\frac{1}{4}$ in. mesh riddle. The sand is rammed tightly into the box, using a peg rammer and taking care that the pattern is not struck. More sand is added, piled up above the edge of the box and again rammed, this time using a flat rammer. Excess sand should be swept off by drawing the edge of a board or a straight-edge over the top of the box. Venting the bottom should be carried out at this stage. A pointed wire, about $\frac{1}{8}$ in. diameter, is repeatedly pushed into the sand over the pattern without actually touching it, so leaving a series of perforations through which gases generated in the mould when casting may find an easy passage of escape (Fig. 4).

Holding the rammed box and turning-over board closely together, the whole is inverted, placing what is now the bottom of the drag on the sand of the foundry floor—which has previously been made level for the purpose. After removing the board, the sand now exposed is smoothed or sleaked over, a thin even layer of parting powder scattered upon the joint, and the upper half or " cope " of the moulding box placed in position as shown in Fig. 5. A brass tube, about $\frac{3}{4}$ in. diameter, is pressed into the sand of the lower part to form a runner. Facing sand is again sieved over the pattern, rougher sand used to fill the box, and rammed as before. After sweeping the excess sand from the top, the brass tube is removed, and a bowl-shaped cavity formed

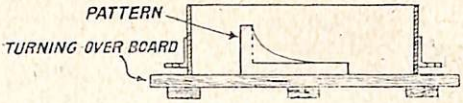


Fig. 3.—Drag ready for ramming

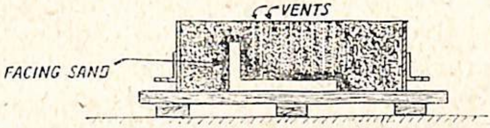


Fig. 4.—Drag rammed

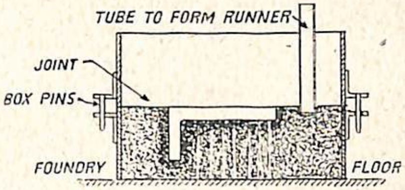


Fig. 5.—Cope ready for ramming

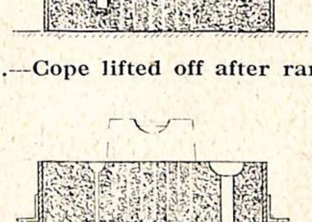


Fig. 6.—Cope lifted off after ramming

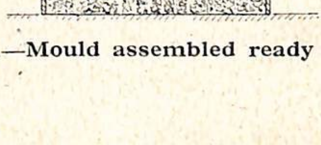


Fig. 7.—Mould assembled ready for casting

to receive the molten metal. The top half, Fig. 6, is now removed from the lower, taking care to bring it up level, and is laid on its back on a bench or on the floor. After very slightly moistening the sand round the pattern in the bottom half, a pointed rod is driven into it. This rod is lightly tapped to loosen the pattern in the sand, after which it is carefully lifted out—using the same rod to obtain a purchase. A channel called the "gate," connecting the impression left by the brass tube with the mould, must be made in the sand. A small hole is made in the top, using another brass tube for the purpose, through which the metal can rise when the mould is full, obviously called the riser. (A riser is not always desirable.) After finishing the mould, that is replacing loose pieces of sand, and smoothing the part with which the metal comes into contact, the mould must be cleared of all particles of loose sand. This is best done with the aid of a pair of bellows. The top part is now replaced on the lower, taking care that no loose sand which could fall into the mould remains in the runner or riser. After putting a couple of 56 lb. weights on opposite corners of the box the mould is ready for the metal (Fig. 7).

Such, briefly, is the process of making a simple mould.

CHAPTER II

TOOLS AND MATERIALS FOR PATTERN MAKING

Before beginning to make a pattern it is usual to have a drawing or sketch of the article to be made ; from this a full size set-out is made on a board. An ordinary drawing board is suitable for small jobs, but for larger work a special table is used and in the case of very large patterns setting out is frequently done on the floor of the shop. The surface of the board, table or floor is covered with chalk so that the lines scribed thereon are more easily seen. Set-outs are prepared to contraction rule to suit the average contraction of the metal in which the casting is to be made. Allowance for machining is made where indicated on the drawing, so that the pattern itself will be rather larger than the finished article.

In the trade moulders never prepare their own patterns, but the pattern maker must have a very sound knowledge of the art of moulding, to say nothing of being able to read and interpret a drawing—quite apart from his own job of constructing patterns ; for these reasons the trade is a highly skilled one.

The curiosities that are sometimes sent to foundries called "patterns," are truly extraordinary, yet attention to a few essentials should enable anyone to make a mouldable pattern even if its maker does not intend to reproduce it himself.

Tools

The first necessity, as in all work to be carried to a satisfactory conclusion, is suitable tackle. The bench should be solid, having a top of not less than 2 in. timbers, the back portion being about $\frac{3}{4}$ in. below the front. A useful size is 7 ft. by 2 ft. 6 in. wide, the height being best determined by the height of the man who is going to use it. Racks to accommodate tools, arranged along the back, will save edge tools from becoming blunted.

Among the various tools essential to a pattern maker for setting out, the try-square and adjustable square are most necessary ; combination squares are ideal and well worth their cost. A contraction rule enables the necessary allowance for the shrinkage of a casting to be made without a calculation for every dimension. They are obtainable in a variety of sizes—12 in., 24 in., 36 in., and so on, with different engravings to suit the contractions of different metals. One edge of each side is frequently engraved as a standard rule and the markings on some, I.C. and I.D., refer to single and double contraction respectively.

Castings having different shapes or sections do not necessarily contract a proportional amount although made in the same metal, and varying compositions of a metal sometimes cause a difference in the amount of contraction. For instance the reduction in diameter of a 12 in. wheel will not be the same as the loss in length of a 12 in. long bar of the same metal.

The following table gives the contraction allowance generally made for various metals.

CONTRACTION ALLOWANCES

Cast steel	$\frac{1}{4}$ in. per ft.
Cast iron	$\frac{1}{8}$,, per ,,
Brass	$\frac{7}{32}$,, per ,,
Gunmetal	$\frac{3}{16}$,, per ,,
Aluminium	$\frac{1}{4}$,, per ,,
Lead	$\frac{5}{16}$,, per ,,

Among other tools used for setting out, the scriber, dividers, marking gauge, and trammels—used for scribing radii too large for dividers—are all most useful and together with inside and outside calipers and a pair of " odd legs " about complete the tools of this class. Chisels, gouges (the latter having a small radius are known as " quick "), planes, spokeshaves, bits and a brace, and saws of various types; hammers, pincers and screwdrivers complete the essential tools that should be possessed by a pattern maker. For the maintenance of tools in good condition a grindstone, rough and fine oilstones, and slip stones are necessary. There are, of course, many other tools that the pattern maker will gradually acquire as they become necessary for his work. Study of a good tool catalogue will reveal the tremendous number on the market.

Most pattern shops are equipped with a number of other tools; hand trimmers for dressing off the ends of timbers and for cutting mitres are probably the most common. To any one interested in woodwork, quite apart from pattern making, one of these tools is a very sound investment. The lathe and bandsaw follow next in general usefulness, but the sanding machine is appreciated almost more than any other by the pattern maker as it saves much time in finishing, besides producing accurate edges, with just the right amount of taper, when required. If a lathe is available a small sanding disc of this kind may be made by glueing a disc of sand or glass paper on to a wood plate and attaching it to the face plate, running the lathe at its fastest speed.

Joints

For joining the various parts of a pattern, screws, nails—of the flat variety—panel pins, and glue, are all used according to the particular requirements of the pattern. Wood pegs are in considerable use for securing two or more parts of a pattern, particularly if turning or some other cutting operation follows. They obviate the risk of damaging edge tools—damage easily caused by a carelessly driven nail or a screw head insufficiently countersunk. Corrugated steel fasteners provide an easy method of joining two or more timbers, they are simple to use and will frequently save time in making more elaborate joints. They are obtained in a variety of sizes from $\frac{1}{4}$ in. wide × 4 corrugations, up to $\frac{3}{4}$ in. wide × 6 corrugations, at quite reasonable prices. Ready mixed glue of a kind such as " Croid " saves time in preparation; if ordinary glue is to be used pearl or bead glue is preferable to the cake.

Plastic wood serves many useful purposes, for filling up screw holes, faults in the timber, and even for building up portions of a pattern. If used in any large hole or to build up awkward corners, it is desirable to use a little at a time, letting the first layer dry off before applying a second, so building up the part a bit at a time. If a large amount is used at once it will probably be loose when dry owing to the shrinkage which takes place. Cramps are very helpful when making glued joints and are frequently supplemented by what are known as " pinch dogs," the latter being flat and U shaped, with the projections pointed. The inside is tapered so that when tapped into two pieces of wood the joint becomes very tight. These dogs are generally made of forged steel or malleable iron, and in various sizes.

Varnishes for finishing

After a pattern has been finished it is usual to give it one or more coats of varnish, partly to assist in easy removal from the sand, and partly to preserve the pattern, which, in a foundry is always exposed to moisture, causing breaking of glued joints, and possible warping of the timber. The best form of varnish is shellac, purchased as French polish, or made by dissolving orange shellac in methylated spirit, using gentle heat to speed up the process. It is customary to use black varnish on the pattern proper, and to colour prints red, these finishes being obtained by adding lamp black or vermilion respectively to the plain varnish. In order to indicate to the moulder that a particular surface has to be machined and therefore requires special care to ensure its soundness, the surface concerned, already painted black, is cross-hatched with yellow lines. Some foundries have their own colours and markings to signify different parts of a pattern, but the colours mentioned above are in general use.

When giving more than one coat of varnish to a pattern, let the first coat dry thoroughly, and rub it down with fine sandpaper before applying a second.

Suitable timber

Timber most generally used for pattern making is pine because it has a straight grain, is easy to work, and does not warp or split readily. Patterns or core boxes which may have to stand up to a lot of use are often made of mahogany, other woods being used when easily available. Plywood is *not* suitable for pattern making owing to the ease with which it warps, and the separation of the laminations which takes place when exposed to dampness.

The fact that the pattern has to be withdrawn from the sand must be borne in mind from the very outset, and this will usually determine its construction. Small plain patterns are often made from one piece of timber, but if of any size they are best built up from several pieces, secured together with glue and screws.

In cases where only one casting is likely to be required a rougher pattern will suffice, though it must be remembered that the better the surface is finished the easier will it leave the mould, thus reducing the time spent in finishing, and possibly rebuilding, the sand.

CHAPTER III

SIMPLE TYPES OF PATTERNS

THE pattern maker is often called upon to use his discretion in deciding whether it would be better, from the point of view of saving money (time), to cast a certain pattern solid, thus saving a core box, and let the machine shop turn out the recess or bore the hole, or to make the casting with the recess cast in and thus save a machining operation. There is a further consideration : if the casting is made solid there is a chance that it will be porous, owing to the large section of metal, but if it has a core, forming a hollow space, the porosity will probably be avoided. When drawings are made by experts they usually decide upon the methods of manufacture, but if not, and the question in the shops becomes contentious, the foremen of the different departments consult as to the best methods.

It is usual to estimate the weight of a casting before it is made, to enable the right amount of metal to be provided. If the pattern is solid, carries no prints, and the wood of which it is made is known the following table is useful for the purpose.

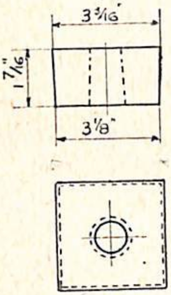
ESTIMATING WEIGHTS OF CASTINGS

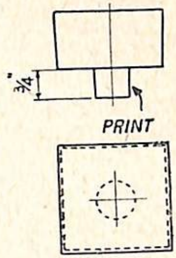
Pattern weighing 1lb.	Weight of castings in lb.				
	Cast iron	Brass	Gunmetal	Aluminium	Lead
Pine (.018)	14.60	16.55	17.00	5.11	22.80
Beech (.025)	10.50	11.90	12.20	3.68	16.40
Oak (.031)	8.10	9.60	9.80	2.97	13.20
Mahogany(.020)	13.15	14.90	15.25	4.60	20.50

Figures in brackets are the weights of one cubic inch in lb.

The art of woodworking, as such, will not be discussed, but the design of some typical patterns may give a general idea of what is necessary, and by adaptation should enable patterns that are " mouldable " to be constructed.

Take the case of a simple block, about 3 in. by 3 in by 1¼ in. deep, having a 1¼ in. hole through the centre, and assume it is to be machined on all six sides. The pattern on the top side, i.e., the face level with the joint of the sand, should be 3 3-16ths in. square, and the bottom face 3⅛ in. square, giving 1-16th in. of taper, or 1-32nd in. on each side, which is ample to give a clean draw (Fig. 8). The hole can be made in two ways. One is by arranging for the pattern to " leave its own " : that is the actual pattern has a hole in it, tapered, which is filled with sand when in the mould. This leaves a slightly conical pillar of sand when the pattern is withdrawn, and requires special care when moulding. Simpler from the pattern maker's point of view is the second method (Fig. 9). Here the pattern carries a circular projection, a core print, and into the hole left by this in the sand a length of round core is fitted which produces a parallel hole in the casting. Whichever method is adopted sufficient allowance must be made if the hole is to be bored out. That is to say, if the hole has to finish 1¼ in. diam. the diameter of the core would be 1 in. Round cores of various standard sizes are stocked in most foundries so that the second way would prove the better from all points of





Figs. 8 (left) and 9.—Alternative methods of forming a hole view—unless large numbers of castings are required. In that case the pattern would be mounted on a moulding machine, and could be arranged to "leave its own," so

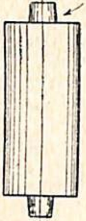


Fig. 10.—Plain roller pattern in one piece, moulded vertically

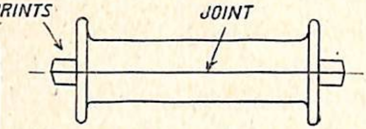


Fig. 11.—Double flanged roller pattern in halves, moulded horizontally

eliminating even the need of placing cores in position. For this purpose the pattern would usually be made of metal.

Cylindrical patterns

Consider next cylindrical types of patterns, rollers for example. If plain throughout its length, such a pattern would be moulded vertically, with the hole through the centre made by a core. A print at both ends ensures that the hole is truly concentric with the casting (Fig. 10). A roller or drum having flanges at both ends would be moulded horizontally (Fig. 11), but with a flange at one end only it

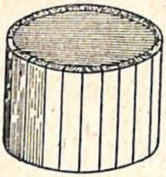


Fig. 10a (left). —Full pattern

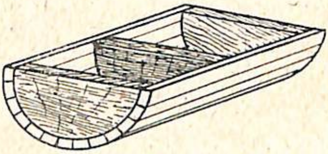


Fig. 11a.—Half pattern

could still be withdrawn if made vertically (Fig. 12), and this is the better way, if the length is not excessive.

A circular pattern, moulded vertically, is made in one piece, but if, because of flanges, it has to be made horizontally, a one piece pattern is not so convenient to the moulder as one in halves. This type enables the upper part of the pattern to be lifted from the lower at the same time as the cope is lifted from the drag.

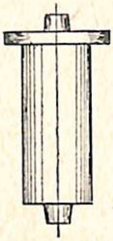


Fig. 12.—Single flanged roller. Pattern in one piece, moulded vertically

The actual construction of patterns for rollers, pipes, and so on varies according to the size. Small rollers up to about 3 in. diam. may be turned from the solid. Larger, up to 6 in. should be built up from laminations, and for patterns bigger the methods shown in Figs. 10a and 11a should be adopted for a full or for a half pattern respectively. After fastening the strips to the circular or semicircular pieces, they may be made perfectly round with a spokeshave and plane, or preferably by turning in a lathe. Usually, two halves are made, and when fastened together may be turned as easily as the pattern in one piece.

When making patterns in halves it is necessary to locate one with the other to avoid having a crossed joint on the casting ; for this purpose dowels are used. Dowels used in the pattern shop are usually either of brass or malleable iron, and consist of a male and female part, two or more of each being accurately positioned in each half of the pattern. Various types are shown in Fig. 14. Dowels made from hard wood are sometimes used, and round nails with the heads cut off driven into one half of the pattern with the ends projecting about $\frac{3}{8}$ in. and holes made in the other half to correspond, are quite effective. Two-part patterns are very common and are generally used when it is necessary to have half the pattern in the cope and half in the drag

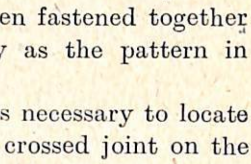


Fig. 13.—Mould of Fig. 11 with core in position

Pulley and flywheel

Next take the pattern for a pulley or flywheel. Wheels of the disc type are easier to construct than those having spokes, a pattern of the former being built up of only a segmental rim, a disc, and two bosses (Fig. 15), with or without a print according to whether a hole is to be cored through the boss or not. If only a small hole is required the boss is just as well cast solid, as it can be drilled out afterwards: if fairly large, 1 in. diameter and upwards, a core is desirable to avoid porosity. For a wheel with spokes a spider must be made in place of the disc. For sizes up to 6 in. diam. this may be cut from one piece of timber, preferably mahogany; if larger, each spoke must be built and fitted separately. For spokes of oval or round section the joint must be made at the level of their greatest width, i.e., on their centre-line. With a flat rim or face the joint is most conveniently made at its top edge so that the levels of the sand joint on the outside of the pattern, and on the

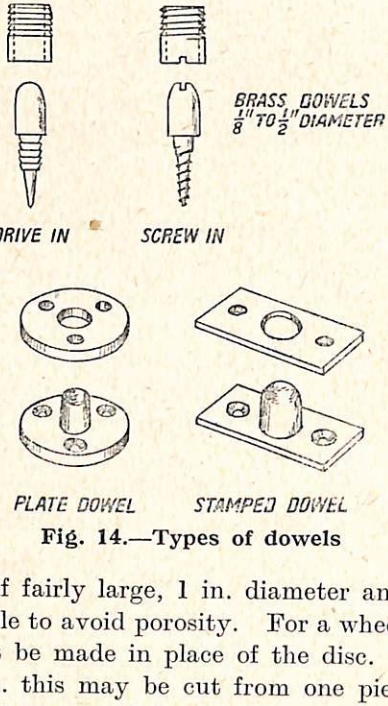


Fig. 14.—Types of dowels

inside between the spokes, will be different. Fig. 16 shows the correct taper on such a pattern and also indicates the position of the joints.

A wheel with a curved rim, such as a handwheel, must have the joint on the outside at its half way line as well as on the inside, in which case exactly half the pattern is in the top box and half in the bottom. Such a pattern would undoubtedly be best made in halves as shown in Fig. 18 rather than in one piece as shown in Fig. 17.

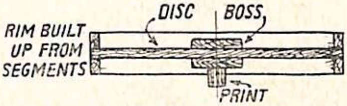


Fig. 15.—Pattern of disc wheel

It sometimes happens that a mould can be more easily made, and the pattern also, by using cores instead of moulding sand to form part of what would generally be called the mould. Such a case is well illustrated by the rope or sheaf wheel shown in Fig. 19, requiring a large groove casting in the rim. Examination of the sketches will enable the construction of the pattern and core box to be easily understood.

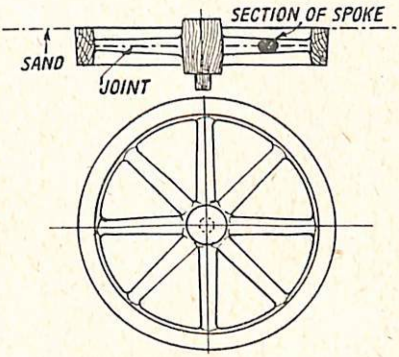
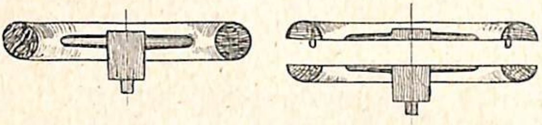


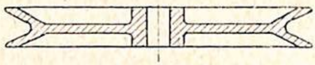
Fig. 16.—Pattern of spoke wheel

Segmental core-box

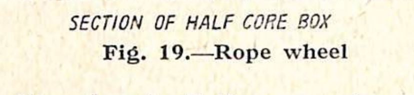
Wheels having two rows of spokes or arms, a design frequently used for large gears or flywheels to provide greater strength than is obtained with only a single row of spokes, may at first sight present some difficulty but this is not really so. The pattern is made " solid," built up if necessary, or if large, made hollow to save timber. By " solid " is meant that the pattern *appears* to be solid when viewed on its exterior. On its lower side (i.e., the side which is worked downwards in the mould, determined by the way the pattern is tapered) are fixed six prints, this number depending upon the number of arms wanted. These prints must be accurately positioned and all the same size. If a boss is required on one or both sides of the wheel extending beyond the face width, wood discs of the desired thickness and diameter are fitted. A circular print to locate the centre core completes the pattern (Fig 21).



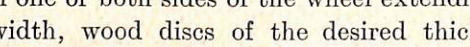
Figs. 17 and 18.—Handwheel patterns



SECTION OF CASTING



SECTION OF PATTERN



SECTION OF HALF CORE BOX

Fig. 19.—Rope wheel

From an accurate "set out" the segmental core-box is constructed as follows. A piece of wood equal in thickness to the thickness of the arms plus the depth of the print, has a hole cut in it of the same shape and size as the print on the pattern. To this is fastened a framework, consisting of two side pieces at 60 degrees, attached to inner and outer cross pieces both of which have been previously cut to the correct radii. A further piece of wood, this time of the same thickness as the arms only, has a hole cut in it the same size as that in the first piece. This is

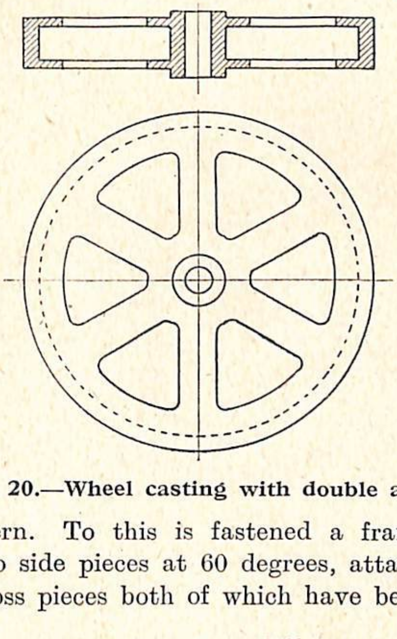


Fig. 20.—Wheel casting with double arms

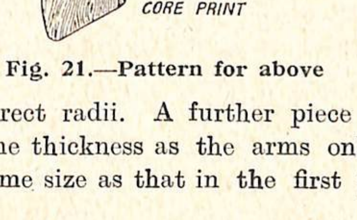


Fig. 21.—Pattern for above

" dowelled " to the top of the frame. Reference to Fig. 22 will make clear its exact construction. From this box six separate cores are made which, when assembled in the mould should form a complete ring. The casting produced by the pattern and core-box described above is shown in Fig. 20.

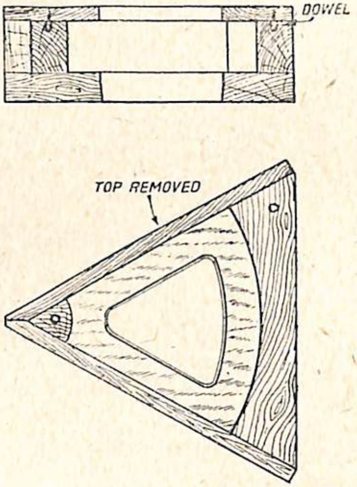


Fig. 22.—Section and plan of segmental core-box

It would be well to mention at this point that a core-box must be capable of being drawn *off* the core, just as a pattern must be removable from the mould, and must therefore, when possible, possess a slight taper to assist this removal.

If, however, the core-box is of the frame variety, built in such a way that after the sand has been rammed up, the sides may be unscrewed from each other and removed separately, no taper need be allowed. In any case, it is nearly always better to build up a core box than to begin with a solid block of timber.

CHAPTER IV

GEAR WHEEL AND BED-PLATE PATTERNS

GEARS, if not machine cut, are generally made on a moulding machine, but it sometimes happens that a gear wheel is wanted in a hurry. If a replacement cannot be made from the old wheel as a pattern (which very often is done) there is no need to go to the trouble of making a complete set of teeth on a pattern, but only to use a pattern having the same external diameter as the diameter of the gear measured over the teeth, and to make a small separate segment $\frac{1}{8}$th or less of the periphery, with teeth on its edge, and of a section that will match the impression left in the mould by the plain pattern. To make the teeth in the sand by this method the segment is placed in the mould—after the plain pattern has been removed—and the sand adjacent to the teeth rammed up. The segment is then withdrawn and moved round a little way, the ramming being continued until a complete circle of teeth is made in the mould. Fig. 23 should make this clear. Although it takes up considerable time in the foundry, the method is cheaper than that of making a pattern with a full ring of teeth.

Many castings that have become worn or even broken, may, if fairly simple, be used as makeshift patterns. Holes in wheels that need boring are best plugged with wood and if a cored hole is needed a print of suitable size should be fastened to the plug. To give an example, a pair of small bevels were wanted for a particular job. The bevels from a breast drill were suitable so they were removed, cleaned, and given a coat of varnish. After moulding and casting the wheels turned out well and required very little " fettling " to make the teeth mate nicely ; a wash in methylated spirit easily removed the varnish and the " patterns " were back again at their old job. Old castings used as patterns which have to be machined on a face or edge must be " lagged " up

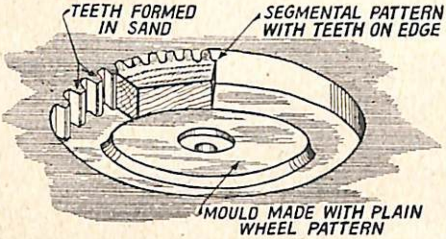

TEETH FORMED IN SAND
SEGMENTAL PATTERN WITH TEETH ON EDGE
MOULD MADE WITH PLAIN WHEEL PATTERN

Fig. 23.—Moulding a gear wheel without full pattern

to provide the necessary allowance. For the purpose cardboard or even lino is often used, stuck on with glue, and preferably varnished. Most pattern shops have a supply of these materials tucked away in a corner for some such purpose.

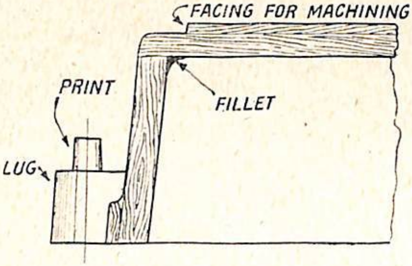


Fig. 24.—Section of bed pattern

Bedplate patterns

Patterns for bedplates of engines, motors, pumps, and so on are generally designed to be cast without the use of cores. Examination of a casting under this category will show that the sides are sloping. This is done essentially to facilitate the process of moulding, but in the opinion of most, it also enhances the appearance. In this type of pattern, therefore, the inside must be finished off as carefully as the outside. Fig. 24 shows a part section of a properly constructed pattern. If internal strengthening ribs are needed they are attached to the pattern, and simply divide the projecting block of sand, forming the inside of the bed, into a number of sections.

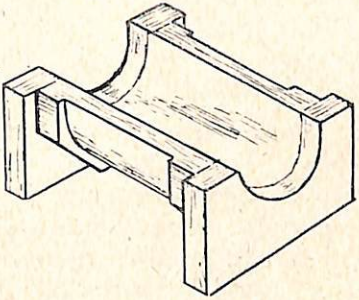


Fig. 25.—Pattern of half bearing brass

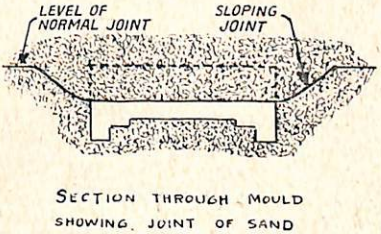


Fig. 26.—Section through mould, showing joint of sand

Joints at angle to horizontal

So far, only patterns having flat joints have been considered ; there are, however, a great many cases where the joint cannot be arranged in the horizontal. No difficulty is experienced in making the joint of the sand between the drag and the cope at an angle as wide even as 80 degrees.

Fig. 25, a pattern for a half bearing brass, provides the simplest example. Here the semi-circular recess is formed by a projecting " cod " of sand depending from the cope. From the lowest point of the recess the sand is sloped upwards to the normal level of the joint. Fig. 26 shows the slope at the joint of the sand.

A propeller moulded without the use of cores provides a further example which requires a sloping joint between the sand of the two halves. Such a pattern is rather difficult to make. It is best to carve each blade to the correct shape and to fasten these to a centre boss which has been turned up in a lathe. A metal pattern of course is really best, particularly if any number of castings are required.

CHAPTER V

CORE-BOXES AND SLOPING JOINTS

Cores for circular holes are generally made on a machine worked by hand, other sections of symmetrical cores are made in boxes. Square or rectangular cores are rammed in a split box such as is shown in Fig. 27. Another quite common type is a core to leave a hole in the side of a casting which for some reason cannot be arranged in the vertical plane. Prints to receive such cores are known as "tail," "draw," or "side" prints. A typical use of this type is shown in Fig. 28. The recess left by the print on the pattern is occupied by a core, the projecting portion of which, protruding into the mould, gives the required hole in the casting. Double cores of the same design where two holes one above the other are wanted, are just as easily made; a core and box are shown in Fig. 29.

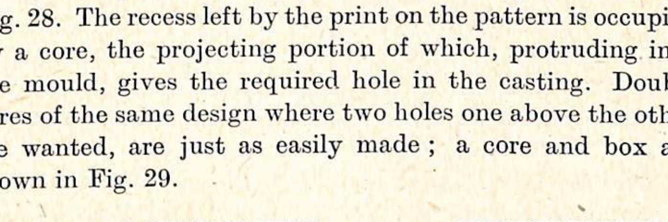

STRIP AND GROOVE TO REGISTER HALVES OF BOX
DOWELS TO REGISTER HALVES OF BOX

Fig. 27.—Boxes for square or other section cores

To save the time in making a core box, particularly for "one off" jobs, a core can often be cut or shaped from a block of core sand already dried. Then, it is usual for the pattern shop to prepare the core to the correct dimensions. These blocks, known as slab cores, are made in an open frame, such as is shown in Fig. 30.

Fig. 31 shows a half core-box with a semicircular recess.

To ensure uniformity of the curved portion throughout its length, it is usual first to make a template in wood as shown to act as a guide when gauging out the recess. If the curved edge of the template is coloured with a crayon, and worked along the full length of the recess, the high places are at once shown by the colour being transferred to the core box. This is only done as the recess is nearing its finished size. Where practicable a template for any section of a recess, or a projection, should be made. They are invaluable when correctness of contour is required, or two similar profiles

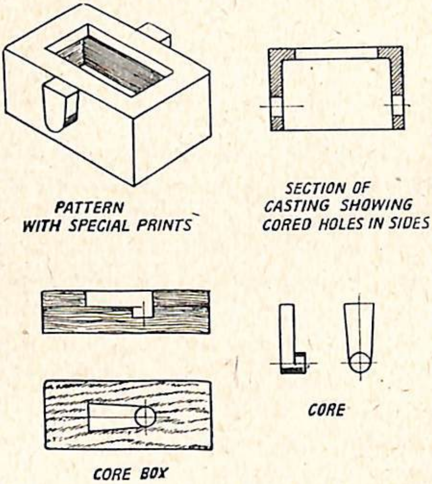


Fig. 28.—Use and construction of tail cores

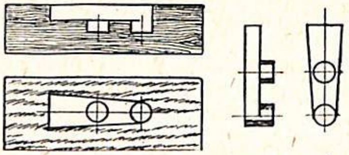


Fig. 29.—Double tail core and box

have to be produced on different parts of the same pattern.

A fairly common design of bracket casting, such as is used to form the body of a bench grinder, is shown in Fig. 32. The recess in the base is provided to save machining the whole area of the base. If the pattern is moulded with the joint about the line " X—X " a core will be necessary to form the recess, Fig. 33. If, however, the face with the recess is arranged at the top, level with the joint of the sand, the two projecting bosses will normally prevent the pattern being withdrawn from the mould. By making the bosses themselves loose from the pattern yet located to it by means of dovetail strips, the pattern can be withdrawn first, and afterwards each boss can be drawn into the space left by the bracket arms, and then taken from the mould.

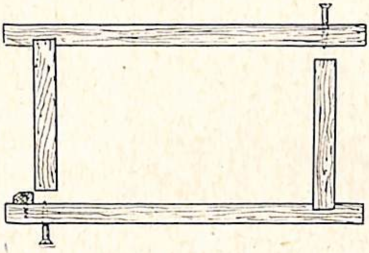


Fig. 30.—Open frame for slab cores

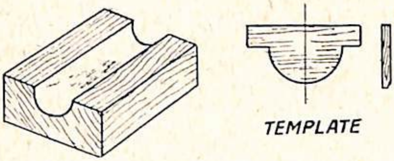


Fig. 31.—Half core-box with template for recess

It is necessary that the combined thickness of the boss and the dovetail piece be less than the thickness of the arms, otherwise they cannot be removed from the mould. The object of these taper dovetails is to keep the bosses in position while ramming the sand. If such bosses are any distance below the level of the joint, a dovetail strip may be continued the full depth of the pattern, so providing something to "get hold of" when removing the bosses (Fig. 34). Modifications of this method may be used to form other kinds of projections on a pattern which cannot be conveniently arranged on the horizontal joint.

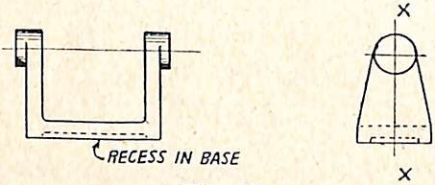


Fig. 32

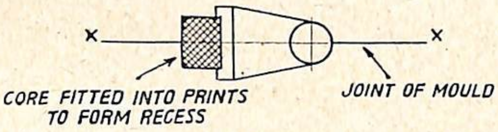


Fig. 33

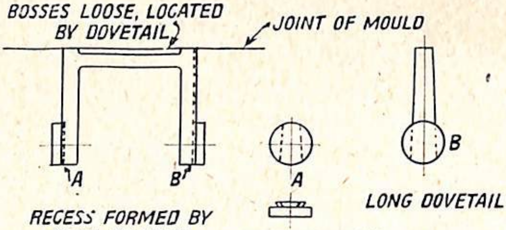

BOSSES LOOSE, LOCATED BY DOVETAIL
JOINT OF MOULD
A
B
A
B
RECESS FORMED BY SAND OF COPE
SHORT DOVETAIL
LONG DOVETAIL

Fig. 34

Pattern with loose bosses

Patterns of angle plates, tables, and slides used on various machine tools are frequently provided with tee slots to hold the heads of bolts. These slots are often cast in using a tee section core. The pattern is solid and simply carries a print or prints to enable the cores to be correctly positioned. The core-box is easily built up from flat strips of wood as shown in Fig. 35.

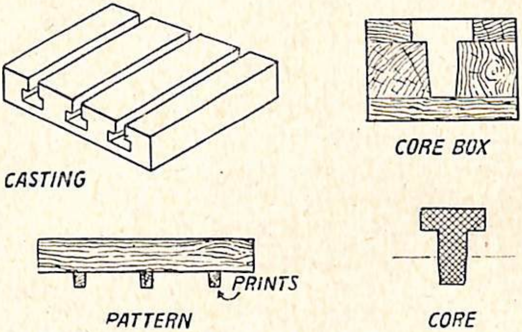


Fig. 35.—Tee slots

Fillets

It should be known that a sudden alteration in the section or shape of a casting, particularly if accompanied by a sharp corner, is a source of weakness. Because of this, a slight radius is, whenever possible, arranged where an angle occurs on a casting. In the pattern shop this radius is provided by using " fillets " fitted at the junction where two surfaces meet, as shown in Fig. 36.

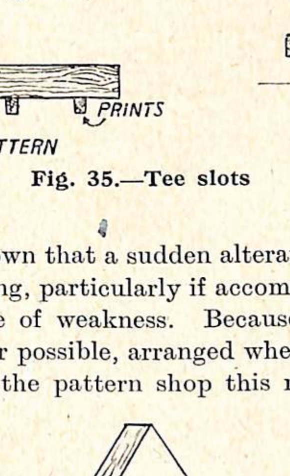
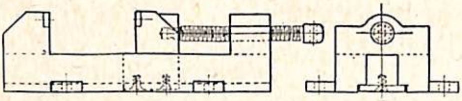
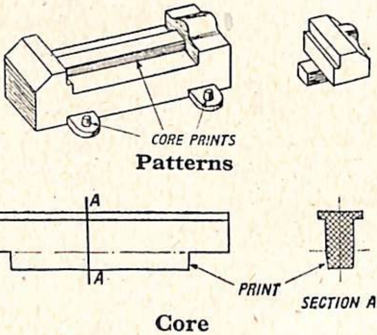


Fig. 36.—Bracket pattern, showing fillets

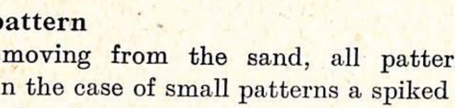
Fillets are made of three materials ; large ones, having a radius of 1 in. or more are made of wood, and the smaller ones of leather or wax. Both the latter are specially made for the job, and are obtained in lengths of any desired size, the size being determined by the radius. As both materials are flexible they are both suitable for fixing round curves. Glue is used to secure them in place, a ball ended tool being used to press firmly to the wood. Of the two, leather is probably the easier to use—being stronger, but wax fillets are handier for fitting round curves. Wax fillets must be warmed before use.



Complete vice



Patterns



Core

Fig. 37.—Machine vice

Lifting a pattern

Before removing from the sand, all patterns require loosening. In the case of small patterns a spiked rod driven into the wood and tapped is sufficient, but larger patterns need considerably heavier blows to loosen them. To avoid damaging the pattern by using a pointed bar and giving it comparatively heavy blows, rapping plates are fitted. These plates, made of malleable iron or mild steel, are recessed into the pattern and contain a hole, rather like a dowel plate, into which a rapping bar is fitted by the moulder. Rapping plates should always be of ample size and firmly screwed to the pattern.

Patterns which have a suitable projection, revealed when the top half of the mould is removed, are withdrawn by lifting from such projection. Where there is nothing to "get hold of," the pointed rod, if used to loosen the pattern, is tapped in a little more firmly, and used to obtain a purchase. Heavier patterns must have special provision for this purpose. Usually a plate, resembling a rapping plate, is fastened to the pattern in such a position that the latter will hang level when suspended from it. These plates have a tapped hole into which a screwed handle may be inserted ; alternatively, a large wood screw with a handle attached—rather like a gimlet—is screwed into the pattern. Two or more points of lift are sometimes needed, and, as the pattern is slowly raised from the mould either by hand or by the crane, it is gently tapped to make sure that no part of the mould is being disturbed.

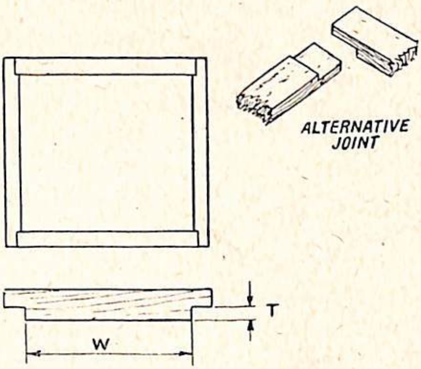


Fig. 38.—Frame pattern and strickle

As a further example in simple pattern design, Fig. 37 shows the correct construction of the body and loose jaw of a machine vice. The upper sketch indicates the two finished castings assembled, and below, the core necessary to produce the slot in which the loose jaw slides. Patterns for such a purpose would generally have allowance for machining all over except on the sides and on the top of the portion that is tapped for the screw.

An economical pattern

It is not always necessary to make a complete pattern even if the pattern making is extremely simple, particularly if timber as well as time can be saved. Consider a perfectly flat plate measuring say 2 ft. 6 in. × 1 ft. 11 in. × $\frac{3}{4}$ in. thick. To make a full pattern for such a plate would require about five square feet of timber. It would have to be in three strips, 11 in. being the greatest width of pine generally stocked, and the three would require end strips to hold them together ; finally, the whole plate would be planed up to thickness. As an economic alternative to the above, construct a frame having its outside dimensions to suit the size of plate required (Fig. 38), and prepare a simple template—or to use its common name, " strickle "—having the dimension T equal to the thickness of the plate and the width W rather less than the inside width of the frame. When in use in the foundry the frame is rammed up in the bottom part, and the interior of the frame also filled with sand. After turning over, the joint is made over the whole surface, followed by ramming up the top part, when this is lifted off and, before withdrawing the frame, the strickle is used to remove the sand inside the frame by drawing it back and forth until the projecting lugs are in contact with the edges of the frame. The surplus sand is removed, the pattern withdrawn, and the whole surface of the recess in the sand so formed finished off in the usual way by the moulder. The extra work involved in the foundry for a plate of this size might take fifteen minutes.

CHAPTER VI

FURTHER EXAMPLES OF PATTERN AND CORE MAKING

In the pattern shop and foundry there is always something to be made that is a little "different," and although it is impossible to describe standard methods of construction to suit every eventuality there are a few typical cases that have a wide application.

Fig. 39 shows the upper part of a hexagonal valve body; the seating for the valve itself would screw into the lower end of this casting. When a valve lifts there must be something to prevent it coming right out of its guide, and in the present case this is effected by a bridge of metal cast integrally with the body as shown. This bridge is produced by a hole passing through the core. Fig. 40 shows three views of the core-box required. The hard wood strip should be a good fit in the slots and might possess a shade of taper to enable it to be withdrawn easily after the box has been rammed up with core sand.

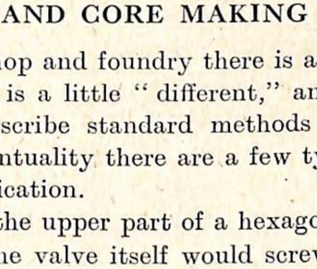


Fig. 39.—Valve body

Cores are sometimes required with impressions to form bosses or other projections inside a casting. Fig. 41 is a casting with internal flanges at both ends and three internal bosses at different levels. The pattern, which would simply be a plain cylinder with a print at one end, is not shown. The core box is in halves. Obviously, if the three bosses set at the angle shown were fixed to the box, when the latter was parted two of the bosses would not come away without destroying their impression left in the sand. The third, however, being at right angles to the joint would withdraw without disturbing the sand. Therefore the two bosses *not* at right angles to the joint could be formed on the end of loose wood plugs, which, after ramming up the core box, are removed before the halves of the box are parted (Fig. 42).

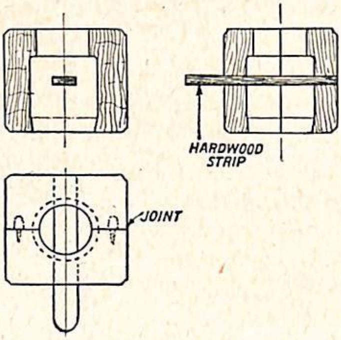
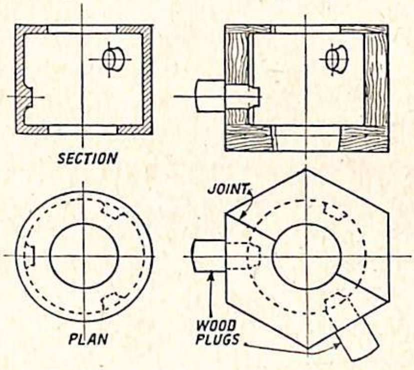


Fig. 40.—Core-box

It might happen that the three bosses referred to above must coincide with three other bosses on the outside of the casting. If this were so, it would be essential to devise some means of locating the core in relation to the mould. This is generally achieved by arranging a " flat " on one side of the core (Fig. 43), and a similar one on the print of the pattern so that the core can be placed only in its recess or print in one way.

A core-box with internal projections like those shown in

Fig. 44 might be made in three separate pieces or even more. When this is necessary it is usual to turn the exterior of the core-box, and to hold the sections together by a metal ring or rings while ramming up. The illustration shows such a box. The flange at the base of the core-box is provided to assist in removing each separate segment without risk of disturbing the core itself.



Casting **Core-box**

Figs. 41 and 42.—Internal flange and bosses

When a number of similar small castings are required from a simple turned pattern, little extra time is needed to make two patterns from the same piece of timber. By this means, foundry production is doubled for practically the same cost, therefore patterns such as shown in Fig. 45 are quite common, and are described as "two on a stick" meaning that one core would be dropped into three prints and serve both patterns. Provided the core diameter is the same, two dissimilar patterns could be made in the same way (Fig. 46).

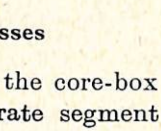


Fig. 43.—Print to locate core in correct relation to mould

Homogeneity of castings

A casting of any depth is more homogeneous at the bottom than the top, and foreign matter will float to the top of a casting, so it sometimes happens that the upper part of a casting is faulty. A very common method of overcoming this trouble is to make the mould of greater depth than actually required, the excess of metal being sawn or parted off during the machining operation. In Fig. 47 " A " represents the actual length required, and " B " the extra metal poured into the mould to ensure that the whole of " A " is sound. The portion " B " is called a " header " in as much as it provides a head of metal. When making a cast iron casting for a die having a length of 18 in. the header " B " would be about 4 in. long. The extra metal on the casting is sometimes of assistance for chucking purposes in the machine shop.

Distortion in castings

Castings play many strange tricks during the process of cooling, not the least of which is distortion caused by internal stresses set up on the metal by uneven cooling. It sometimes happens then, that a casting which should be straight is found upon examination to be appreciably bent. An experienced pattern maker will sometimes suspect the possibility of warping. Sections as shown in Fig. 48 are particularly prone to this trouble, and provision would be made when constructing the pattern for giving it an opposite camber, even if this were not actually done at the outset. Fig. 49 shows what happens to such castings. The ends may quite easily lift as much as $\frac{3}{8}$ in. in 3 ft. The pattern with opposite camber is indicated in Fig. 50. No hard and fast rules can be laid down and the only safe way is by trial and error. To illustrate what can happen,

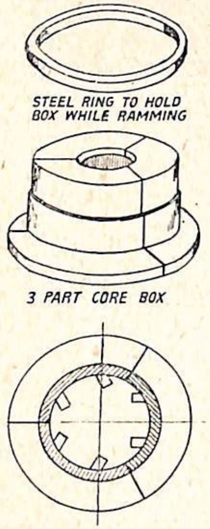


Fig. 44.—Section of core-box with internal projections

a casting 2 ft. 6 in. long was made from a straight pattern, the ends lifted ¼ in., so the pattern was altered to have the same amount of camber but in the opposite direction.

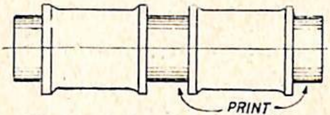


Fig. 45.—Pattern for two similar castings

Instead of this effecting a cure, a second casting was found to have bent in the opposite direction to the first—that is, in the *same* direction as the pattern. The pattern was again modified, this time with only ⅛ in. of camber, and on this occasion the resulting casting turned out straight!

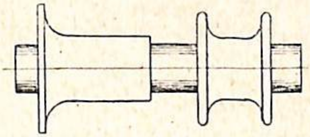


Fig. 46.—Pattern for dissimilar castings

Patterns requiring possible alterations as described above might with advantage be made in some metal that could be bent slightly if required, such as brass or a tin-lead alloy. If a preliminary wood pattern is made, sufficient allowance must be provided for the contraction of the metal pattern *and* of the final casting. Such patterns are referred to as master patterns.

Another type of casting likely to give similar trouble is shown in Fig. 51. This represents a tank plate with three edges flanged and the fourth plain. Upon cooling, the plate will be concave on the inside for some distance from the plain edge.

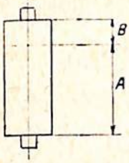


Fig. 47.—Pattern with extra length to form head

Two other contributory causes of camber are: the temperature of the metal when casting, and the position of the gates admitting metal to the mould.

Use of loose pieces on pattern

The use of loose pieces on a pattern located to it by taper dovetails has already been mentioned, but a further example of this rather important type of work may not come amiss.

Fig. 52 shows an extension piece for an ordinary lamp post—used to raise the height of the lamp with a view to providing better visibility. This is decorated by means of fluting. If a straightforward pattern in halves were used it is obvious that the "flutes" nearest the joint would not draw unless they were cut as shown in Fig. 53. Although satisfactory for some purposes, this might not always be approved owing to the lack of symmetry of the fluting. To make each flute symmetrical, loose pieces are again required. In Fig. 54 is shown the section of a pattern having 12 flutes, two arranged on each loose strip and two on each half of the

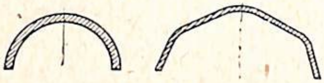


Fig. 48

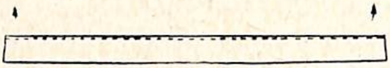


Fig. 49.—Distortion of casting made from a straight pattern

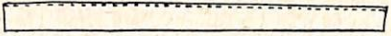


Fig. 50.—Pattern with opposite camber

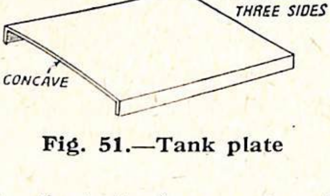


Fig. 51.—Tank plate

main pattern. Dovetail pieces are arranged in such a way that the centre portion is removed first, and the strips then withdrawn inwards. The dovetail pieces are made of some hard wood. If large numbers of castings are required, steel dovetail pieces may with advantage be let into the strips and into the body of the patterns. Figs. 55 and 56 show the hard wood strips when looking on the joint of the pattern.

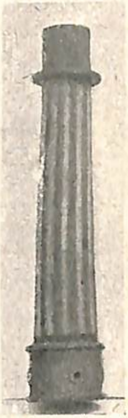
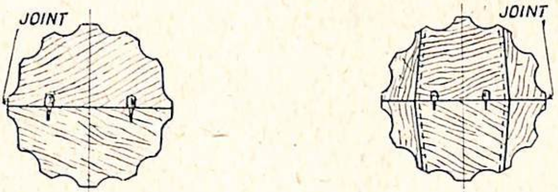


Fig. 52.
Lamp post extension piece

Portions of a pattern that cannot be removed from the mould in a vertical direction are attached in such a way that the moulder is able to unfasten them after he has rammed up the mould and removed the cope, enabling the main part of the pattern to be lifted out first and the detached pieces to be removed at a suitable angle afterwards. Figs. 57 and 58 show two representative cases. Fig. 58 also shows the method of constructing a curved plate by battens fitted to curved end flanges. The rough sand left between spaces of adjacent battens is easily cleaned off by the moulder and the whole made into a uniform radius—much simpler than for the pattern shop to have to radius each separate batten of the pattern.



Figs. 53 and 54.—Sections of fluted patterns

The strickle method as shown in Fig. 38 is equally applicable to a curved plate as to a flat one. Other types of patterns not removable from the mould by a straight draw are shown in Fig. 59.

For a baffle, the pattern must of course be a perfect helix; and to twist a pattern out of a mould calls for considerable skill and a steady hand on the part of the moulder.

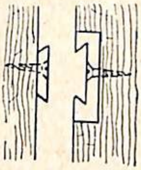


Fig. 55.—Metal dovetail pieces

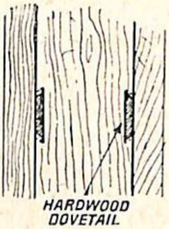


Fig. 56.—Taper dovetail (view on joint)

Castings with projections

It often happens that a casting is required with some kind of projection, either for attaching it to another for lifting, or, in parts of machinery, perhaps a spindle for a revolving part to work on. For one reason or another—strength, wearing properties and the like—it may be desirable to have a different metal from that of which the casting itself is made, and so the method known as " casting in " is used. This consists simply of arranging a part of the material to be cast in to project into the mould in such a way that when the casting is made the fluid metal runs round it, and when set holds it firmly in position. The molten metal does not necessarily

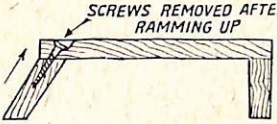


Fig. 57.—Pattern with sloping flange

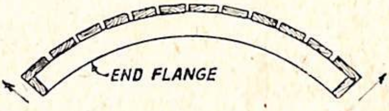


Fig. 58.—Segmental plate pattern

fuse or even partly fuse the exposed end of the rod, bolt, or whatever it is, and obviously no one would attempt to cast, say a lead eye bolt into a block of cast iron ! Therefore, to ensure that the eye bolt cannot be pulled out, some form of key must be provided. Fig. 60 shows four common methods of keying some typical objects. It is true that this concerns the blacksmith more than the pattern maker, but in most cases the pattern shop must provide prints on the pattern ; in this case they are not for sand cores but for pieces of metal. Small section shackles and similar parts may be pressed into the sand without a special print but for anything over say $\frac{1}{4}$ in. diameter a print is necessary.

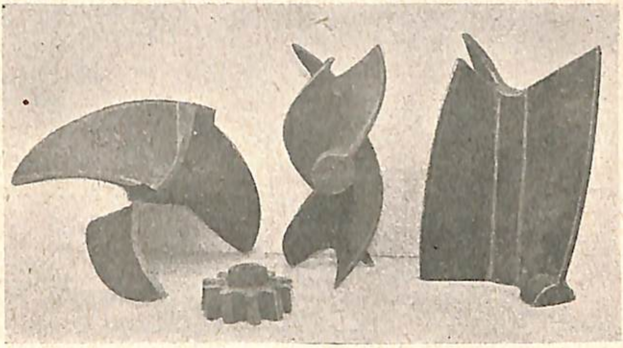


Fig. 59.—Examples of patterns that cannot be removed by straight draw

An example of "casting in" is provided by the lifting handle of a manhole cover.

In Fig. 61 are shown a section through a manhole cover, the pattern with a print to locate the core which forms the recess for the hand, and the core-box itself, into which is fitted a bar of steel before it is rammed up with core sand. This steel bar remains in the core until the mould is cast. The object of the two bosses is to ensure that the metal has a chance to flow round the ends of the bar projecting from the core into the mould.

Name plates present no difficulty to the pattern maker but a word about the design of them may be useful. They must look well, and, with this object in view careful spacing of the letters is vital. Generally a thin back plate is provided having a beading round the edge with semi circular corners to receive fixing screws. The appropriate lettering is then attached. Letters of Doric, Roman, or sharp face are used as required and these may be obtained from $\frac{1}{8}$ in. high and upwards. Four methods of fastening them are in general use: by an adhesive, by fine sprigs, by pointed projections formed on the underside of the letter and gently driven into the back plate, and, for larger letters, screws. Letters and figures should have plenty of taper to ensure a clean draw. Name plate patterns made flat and cast in a

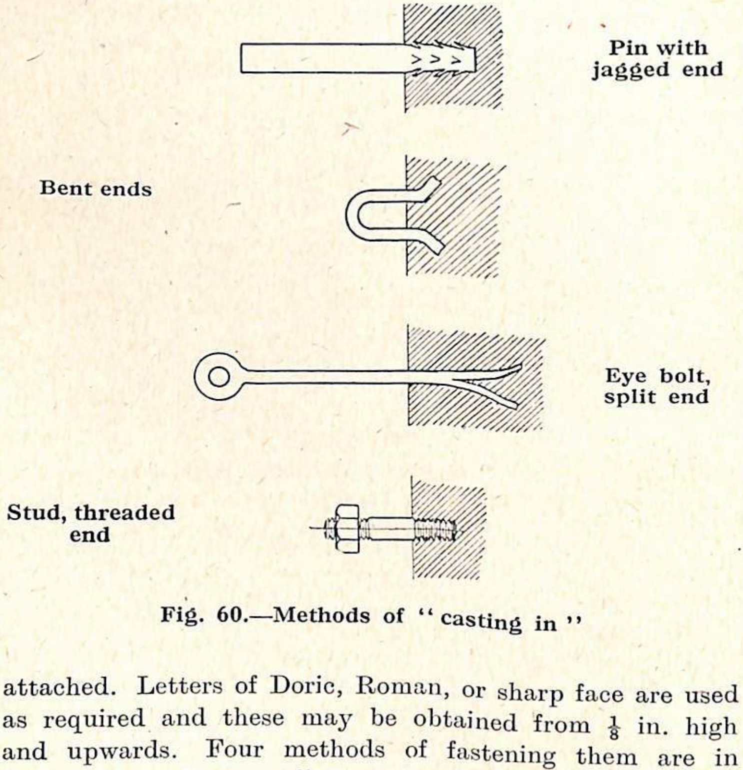


Fig. 60.—Methods of "casting in"

soft metal, can easily be bent to fasten on to a curved surface (Fig. 62).

When figures have to be cast on to the actual casting they are attached to a strip of wood and bedded into the mould after the pattern has been lifted out. They can be fixed to the pattern itself if their presence does not interfere with the removal of the pattern. For curved surfaces they must be fixed to a strip of wood having the same radius as that of the pattern. Fig. 63 illustrates the above.

Plaster of Paris

The use of plaster of Paris for patterns is generally confined to small, intricate, and decorative work. An ornamental panel for a radiator which has a design repeated throughout its length would be a costly pattern to make in wood—indeed the services of a wood carver rather than a pattern maker are needed for such work. If, however, one section of the design is made and from this a negative cast by pouring plaster into a suitable frame, this mould, when dry and coated with oil or shellac, may be used to produce any number of positives, also in plaster. These positives are then fixed to the framework of the panel to make a continuous design, from which the moulder will make his sand mould.

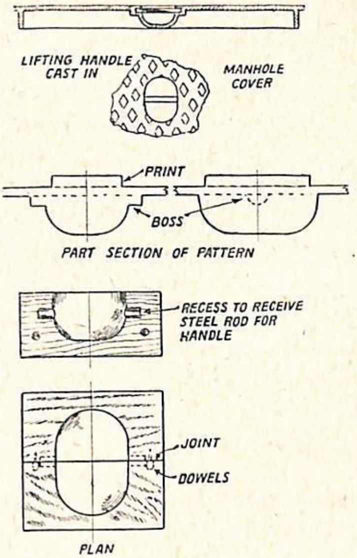
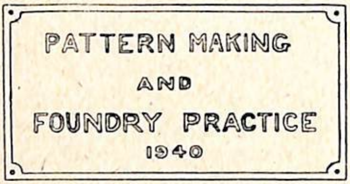


Fig. 61.—Design of pattern and core-box for casting in lifting handles

Another use for plaster is in making temporary alterations to existing patterns. Suppose for instance that a disc wheel is required and that the only pattern available is a wheel with spokes. If the pattern is in halves all that is necessary is to place each half joint downwards on a flat and level plate and to pour plaster into the space between the arms. If the full depth of the arms should be too thick for a disc wheel only the required quantity of plastic is poured in each space, and the moulder will be able to stop off the projecting edges of the spokes in the mould. It will be understood that such a method is only makeshift.



DESIGN FOR NAME-PLATE

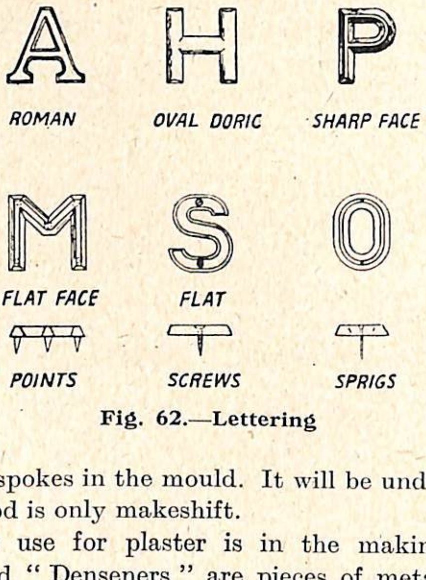


Fig. 62.—Lettering

One other use for plaster is in the making of chills. " Chills " and " Denseners " are pieces of metal built into a mould so that the molten metal comes into contact with them when the mould is cast.

The face of a chill or densener must follow exactly the outline of the pattern so that there are no unsightly marks on the finished casting where the chill joins the sand. To make a wood pattern for the chill might be troublesome, particularly if the pattern is awkwardly shaped where the chill is needed.

If a small frame is made to fit round that part of the pattern where the chill is to be placed, plaster can be poured in, and a perfectly matching pattern is produced which is used to make the metal chill.

Such chills and denseners are usually small as they are only required locally, so that the contraction of the chill casting from the plaster pattern is not important. The act of "rapping" the pattern in the sand will compensate for the shrinkage of the metal, as rapping naturally increases the size of the mould. Obviously, plaster patterns must be rapped with a gentle hand.

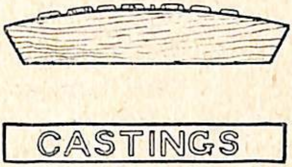


Fig. 63.—Name plate for bedding in

Turning wood patterns in the lathe

To anyone who is familiar with ordinary wood turning no difficulty should be experienced in making patterns in the lathe. The chief difference lies in the fact that a wood turner is concerned with pleasing lines and a good finish, while the pattern turner aims at accuracy in dimension and provision of taper.

Long work is turned between centres, and to avoid any possibility of unwanted movement metal plates are screwed on to the ends. One plate must have a slot to take the driving

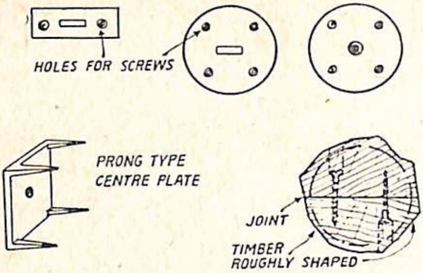


Fig. 64.—Jointed pattern

or prong centre, the other a countersunk hole to suit the back centre. Patterns in halves are turned in exactly the same way by using plates, which also hold the two halves together.

For additional security the halves should be screwed together, taking care that the screws are countersunk well below the finished surface and that the business end does not come out on the other side (Fig. 64). Screw holes in patterns are not detrimental as they are easily filled with

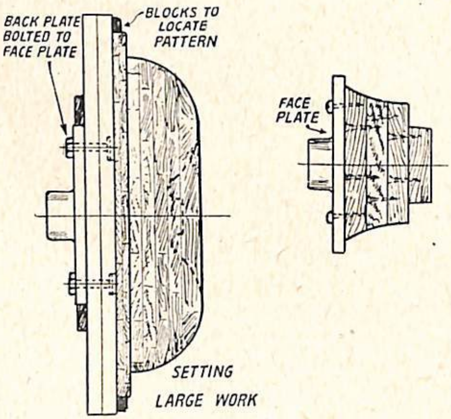


Fig. 65.—Laminated pattern with glued and screwed joints

plastic wood. Time in turning is saved if the timber is roughly cut to shape before beginning to work on it in the lathe. (See illustration.)

Short patterns of larger diameter may be screwed directly on to the face plate or on to a wood back plate fixed to the iron one. On heavy work a few blocks screwed to the wood back plate are useful for supporting the pattern ; also they enable it to be removed and replaced if need be without difficult setting. Fig. 65 shows two methods of faceplate mounting.

CHAPTER VII

SOME MORE INTRICATE PATTERNS

Castings of most intricate and complicated design are constantly being made, often with the use of quite a number of separate cores all of which fit snugly into their respective prints. Patterns for such castings, and core-boxes, also need great care in accurate construction, and in the primary setting out. Examples of more complicated designs will now be described.

Body and volute of centrifugal pump

The section and elevation of the body (Fig. 66) illustrate a common design. It will be noticed that the recess in the base is carried up to form a hollow in the bearing housing. The flange carries a facing, on the face of which a recess is turned to receive a corresponding spigot on the volute. Fig. 67 shows the pattern, the bottom left hand view being a side elevation, and above this a view of the joint. The two dowel plates can easily be seen—also holes made in the wood by the rapping bar; the lighter portions are core

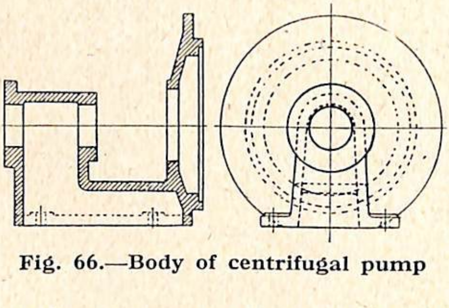


Fig. 66.—Body of centrifugal pump

prints. The circular core-box, built up from segments, was turned in a lathe, the core made in it obviously leaving the hole in the flanged end. The remaining upper views show the two halves of the main core-box, and careful inspection will reveal the joints in the timber used in its construction. The " L " shaped cavity seen in both halves has nothing to do with the core; these are accidentally formed when building up the box. The bottom right hand view is of the finished casting.

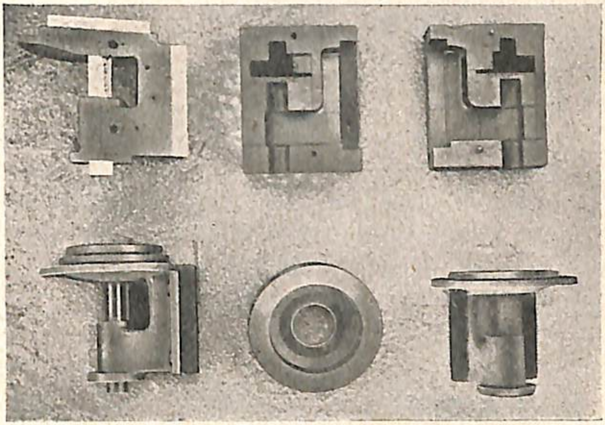


Fig. 67.—Pattern, core-box and casting of pump body

Although at first sight it appears less complicated, the volute is more awkward to make because of the spiral, which has to be formed internally. Fig. 68 shows the general design of the casting. In the top right hand of Fig. 69 can be seen the quite simple pattern with its various prints. The internal spirals are made by using two separate cores. One, carrying the branch, is mounted on the other which terminates in the oval hole seen in the view of the casting and on the pattern as an oval print. Both halves of both core-boxes are shown, and although they may appear simple

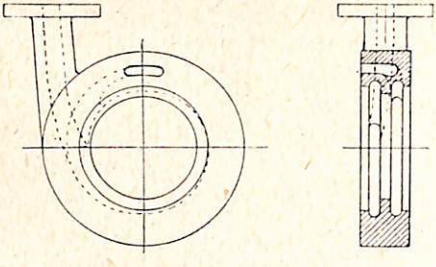


Fig. 68.—Volute of centrifugal pump

enough, considerable thought has to be given to design; the pattern maker has only a drawing such as Fig. 40, from which to work.

A lathe bed pattern

The bed of a lathe may present a somewhat awkward problem at first sight and as it represents all kinds of box section castings it will serve to illustrate the generally accepted methods of manufacture.

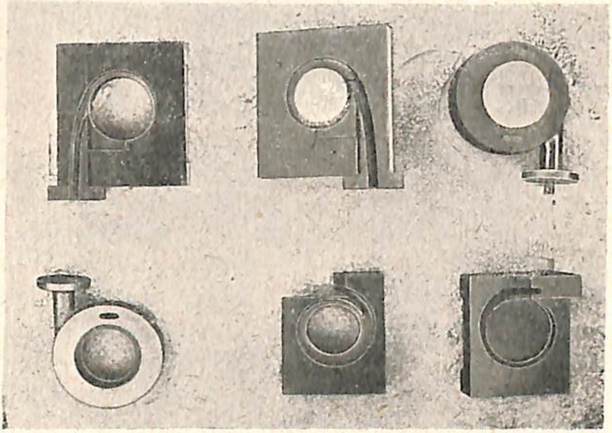


Fig. 69.—Pattern, core-box and casting of volute

Reference has already been made to the fact that the cleanest and closest grained metal is to be found at the lowest point of a casting viewed from its position in the mould, and therefore those surfaces which have to be machined and appear absolutely free from blemish must be arranged at the bottom of the mould.

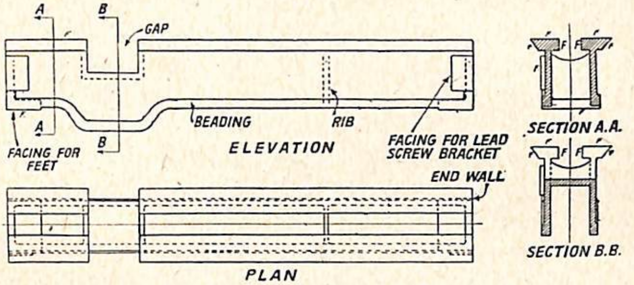


Fig. 70.—Lathe bed with gap

It must not be inferred that a casting is necessarily faulty on its upper surfaces, but if faults *do* occur they will invariably be found at the top. Therefore the top surface of a lathe bed must be cast downwards, that is to say, it is "upside down" in the mould compared with its normal position. This determines the design of the pattern.

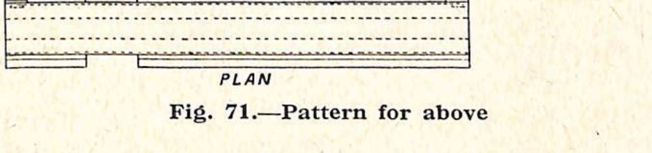


Fig. 71.—Pattern for above

The finished bed is shown in Fig. 70 and requires no comment. The pattern (Fig. 71) outwardly appears as a solid block of wood, but for the three reasons, strength, lightness, and economy, would be boxed up as seen in the sectional view. On to this " box " are dowelled the four loose strips forming the top guides, and these must be of sufficient size to allow for machining, as indicated in the drawing of the bed by the letter F. Running the full length of the bed between the loose pieces is a core print, and the width of this is determined by the distance between the two top guides—less machining allowance. Facings at either end to receive the lead screw brackets are dovetailed into place, so that they may be drawn inwards.

Partly for strength and partly for the sake of appearances, a beading is fastened on the upper edge of the pattern. This is returned at the ends to the top guide strips on one side, and up to the loose facings on the other. The strengthened portion above the gap is a block suitably shaped and fastened to the main body of the pattern. The beading is carried round the edges of this block. If the bed is a large one this block would also be boxed up. Two more facings required for the feet are fixed at opposite ends, and here again machining must be allowed. Note that these are cast at the top, and although they have to be machined, the necessity for perfect metal is not so important as for the slides.

In the case under consideration the main core is made in three sections. In a longer bed with additional intermediate ribs extra sections would be used.

Core-boxes for a lathe bed pattern

Fig. 72 shows the core-box to form the inside of the bed under the gap. The frame construction is clearly indicated. Inside it on the left are fitted pieces to form one of the end walls and the internal flange to support the foot. The large rectangular block produces the inside shape of the metal surrounding the gap. The only piece to be worked loose is the upper strip having a width " W." This width is equiva-

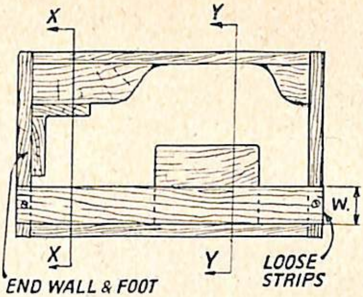
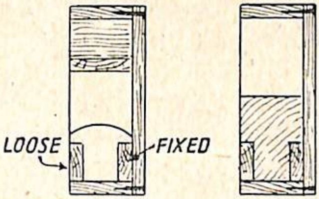
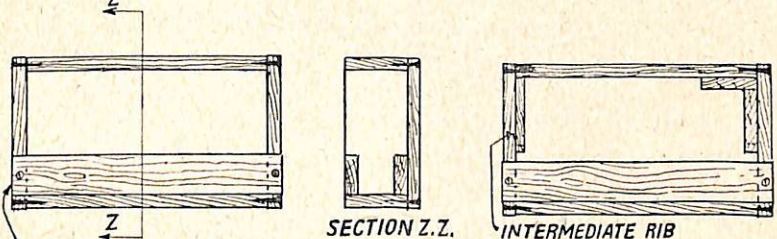


Fig. 72



SECTION X.X. SECTION Y.Y.

Fig. 73



SECTION Z.Z.

Fig. 74

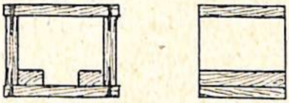


Fig. 75

Core-boxes for lathe bed

lent to the depth of the core print *plus* the thickness of the top slides measured on the inside. Two sections through this core-box are given in Fig. 73. Section " X " " X " shows the radius of that part which forms the end wall of metal.

Fig. 74 shows two views of another box to make the other sections of core. Except for the two strips (the top one loose as before) no other pieces are fitted when making the centre core. After this has been made the loose pieces shown in position in the other view are screwed into place to form the intermediate rib, and, on the right hand side, the wall and internal flange. The rib must have the same radius as that on the end walls.

One other core-box is required. This is rectangular in shape (Fig. 75) with two fixed strips equal to the depth of the core print only. This makes the core which forms the gap itself.

Taper has not yet been mentioned. Naturally this is desirable on the outside of the pattern and on the core print to ensure a clean draw ; about 1-16th in. per foot on each side is sufficient.

Steam engine cylinder

The design of a steam engine cylinder lends itself as an example in more advanced pattern work. An example is shown in Fig. 76.

To obtain an idea of what is required the three views of the casting should be studied carefully. The longitudinal section clearly shows the steam inlet ports, the steam chest and the facing and guide inside the latter for the slide valve. The section on the right is a view drawn on the centre line and reveals the shape of the exhaust port and the valve guide strips at either side of the facing. The plan view, looking into the steam chest, should further assist in visualising the cylinder casting.

Probably the most difficult part at first sight is the forming of the internal steam ports. In all, this casting requires seven separate cores : main cylinder core, left and right hand steam inlet cores, exhaust port core, one core for the steam chest in two separate halves, and two circular cores, one for the

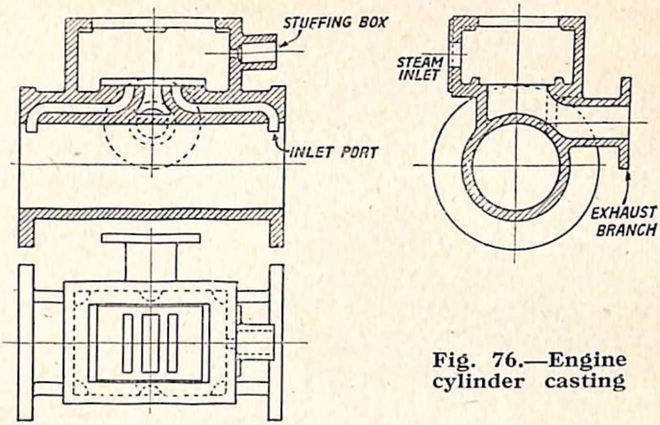


Fig. 76.—Engine cylinder casting

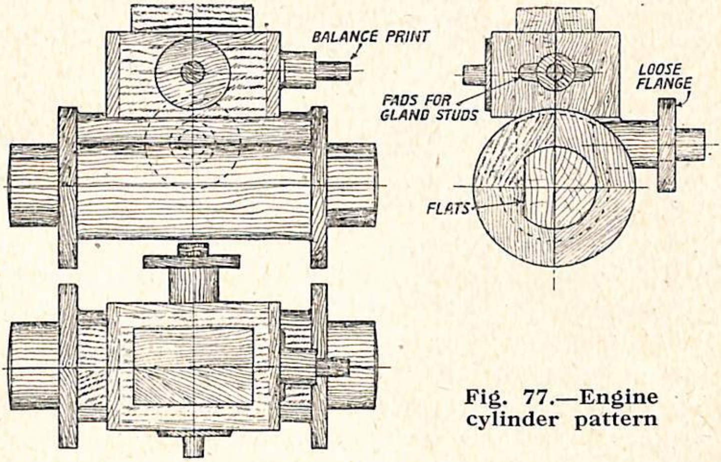


Fig. 77.—Engine cylinder pattern

stuffing box and one for the hole in the steam inlet facing on the side of the chest. The pattern carries prints for all these and as some of them are located on the joint line of the pattern they also will have to be in halves.

The actual construction of the pattern depends to some extent upon the size of the engine. Small cylinders with a bore up to 4 in. would have the main circular part of the pattern turned up from two pieces of timber jointed together ; above this size the use of segmental strips is recommended. Whichever method is adopted the body with its core prints is constructed first, and to this are fitted the end flanges. Note the flats on the prints to set the main core in its correct position in the mould.

That part under the steam chest in which are formed the steam ports is shaped to fit the radius of the cylinder wall, and on to it is built the chest itself. The latter are both in halves, as also is the rectangular print to support the steam chest core.

A circular facing is attached to one side of the chest and it has a round print in the centre. On the end, a split boss with core print forms the stuffing box for the valve rod. The two " pads " or small facings on either side of the stuffing box are provided to give additional metal where the gland studs will be fitted. The chamber in the stuffing box is generally of a size that will permit coring except on the smallest engines. The small hole at the bottom end is better machined out from the solid. It will thus be seen that the stuffing box core does not " cut through " ; that is to say it does not touch the chest core, but allows the metal to flow between them. It overhangs into the mould and is supported only by a print at one end. In such cases the print must be long enough to prevent the core overbalancing when it is laid in position. " Balance print " is the term used for these specially long prints. Finally, the exhaust branch is fitted. As this is at right angles to the joint, it is made in one circular piece with a print at one end. Here the print is made long enough to accommodate the flange, which will slide along until it butts up to the shoulder. The end fitting up to the body must be suitably shaped to ensure that it will be at the correct angle.

Cylinder core-boxes

The construction of the four core-boxes is shown in Figs. 78 to 82. Only half a core-box is necessary for the main core, and its construction is clearly shown. At each end two removable pieces are fitted to produce flats on the core that will correspond with the flats on the pattern prints. The two small projections are also removable, and two wider ones must be provided to take their place. When using this box, two separate half cores are made, one with the flats and the small projections, the other with the flats taken out and the wide projections substituted.

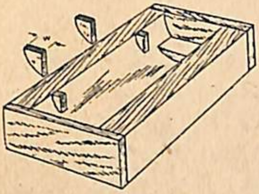


Fig. 78.—Half core-box for cylinder

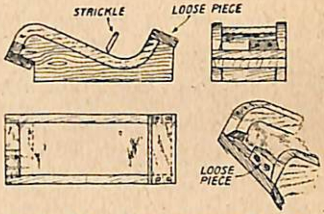


Fig. 79.—Open type core-box for inlet port

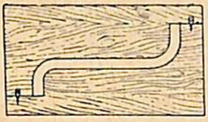


Fig. 80.—Core-box in halves

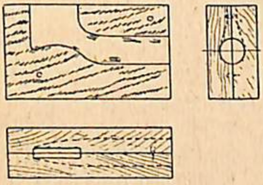


Fig. 81.—Core-box for exhaust port

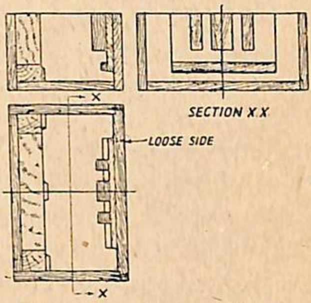


Fig. 82.—Steam chest core-box

When the two half cores are made they are stuck together to form a complete core. (" Stuck " is used in its real sense, the coremaker using gum for the purpose.)

A full core-box in halves could of course be made which would produce a one piece core, and no doubt many pattern makers would do this, particularly when a number of cores were required. It would simply involve making two similar halves, dowelling them together, and fitting the two extra projections into the top half.

The core-box for steam inlet ports again offers a choice of design ; a jointed or open box may be made, and these two methods of construction are shown in Figs. 79 and 80. Except for the end of the cores which fit into the recesses of the main core, both are the same, and are referred to as left and right hand. A slight modification to the core-box by means of a loose piece enables both to be made from one box. The open box provides an interesting example of the way to make an awkwardly shaped core without a top part. The upper surface of the core is produced by a strickle which follows the lines of the two outside edges of the box.

The sketch of one end of this open box is included to show more clearly how, by moving the loose piece from left to right, the box is handed.

The steps at the end of these cores are required to form a bearing when assembling the cores in the mould, and they fit into the stepped recesses of the main core left by the projecting pieces of Fig. 78.

The exhaust port requires a full core-box in halves ; its construction presents no difficulty—only patience in obtaining the correct shape (Fig. 81).

The box for the steam chest is constructed as shown in Fig. 82. Here again only half a box is used and as both halves of the core are identical no alteration to the box is necessary. One end must be removable as it carries projections for locating the port cores, and strips on a facing for the valve guide. The two remaining cores of circular section, one for the stuffing box and one for the steam inlet, would probably be stock sizes, made either on a machine or in a standard core-box.

Patterns for machine moulding

Patterns for mass production work are a different proposition. Very often they are made of metal, and because most ordinary pattern shops concern themselves only with wood, metal patterns are generally made by a special department. As, however, many of these patterns are made from castings, the department must work in close co-operation with the woodworkers as the primary pattern or "master" is made by the latter. It has already been mentioned that when making a wood pattern for use as a master, extra contraction allowance must be made to allow for the shrinkages which occur twice. For the sake of cheapness, cast iron is often used for metal patterns, but brass and aluminium are particularly useful because castings made from these metals can be "got up"—or prepared for moulding—with comparative ease. Aluminium has the added advantage of lightness.

White metal (an alloy of lead and antimony) is suitable for certain types of patterns and pattern plates. Its weight is its chief disadvantage.

Lead is sometimes used, but its softness and weight make it less satisfactory than the others. When wood is used it is desirable that it should be mahogany or some other hard wood. Such patterns for repetition work are generally mounted on a moulding machine. Briefly, the technique of machine moulding is as follows.

The pattern, carefully prepared and with a smooth finish, is mounted on a plate, sometimes made of wood with metal strengthening strips let in, or on a metal plate often made of cast iron and machined on both surfaces. In some cases the plate and pattern are made as one casting. Generally it is simpler and better to mount the pattern on to a separate plate, as this can be machined first. The flat surface obtained in this way produces a better joint on the mould than would an unmachined surface. The plate carries pins to receive the holes in the lugs of a suitable standard sized box; alternatively, by removing these pins, the holes left will accommodate the pins in the lugs of the corresponding half box. The plate, with the pattern or patterns on it, is then fitted to the table of the machine, the appropriate box part placed in position, and the sand thrown in. When the machine is operated, it jolts the sand into the necessary degree of consolidation in the case of the "jolt" machine. Squeeze type machines achieve the same result but by a different method—suggested by the name "squeeze."

After the ramming up operation, the mould is drawn from the pattern, or the pattern from the mould, depending upon the type of machine. Generally the equivalent of hand rapping is achieved by rapid vibration except on small hand machines, and it follows that under these ideal conditions, which eliminate all risk of a shaky hand and uneven rapping, almost perfect moulds are produced which require a minimum of finishing. The rammed boxes are taken from the machine and placed on the floor in rows. If the whole of the pattern is moulded in the drag an equal number of "flat backs" are rammed up, and, after cutting the runner (and riser if required), the "copes" are placed on the "drags" and the moulds are ready for casting. If the pattern is not flat on the top surface, the two halves of the pattern, one on each side of the plate, are accurately mounted in relation to each other. Thus, when a half mould from each side of the plate is rammed and placed on the other no joint will be noticeable on the finished casting.

In most types of machine this involves turning the plate over on the machine after ramming up the bottom half of the mould before the top half can be made, unless the machine is of the type that will ram the top and bottom simultaneously.

By using what are known as reversible plates two half moulds are rammed up from the same side of the plate, and these when placed together form a complete mould.

Patterns for machine moulding need not have as much taper as those used for ordinary floor moulding owing to the perfect draw obtained by the use of machines.

Methods of mounting patterns

Some methods of mounting patterns will now be considered. Remember that this process is generally for mass production purposes, so when thousands of similar castings are required the cost of several patterns of the same article is not of very great consideration, compared with the increased production obtained; particularly if they are of fairly simple design.

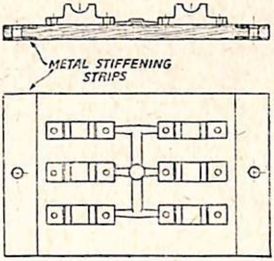


Fig. 83.—Group of pedestals on wood plate

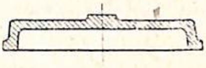


Fig. 84.—Section through cover casting

A group of six small pedestals mounted on a wood plate with metal strengthening strips is shown in Fig. 83. The channels and ingates which admit the metal to the mould are also shown and these should always be arranged in suitable positions on the plate to save the moulder having to cut them after the mould is removed from the machine.

The face of the cope for a mould of this type would be perfectly flat.

To produce a casting shaped as in Fig. 84, the inside must be formed by a sand projection (unless a separate core is fitted into the mould). The pattern would be mounted on one side of the plate and on the opposite side a recess is provided. Naturally, this recess must be concentric with the pattern. (Fig. 85.) If it is intended to use a core to form the recess in the casting the plate must carry a print on its underside in place of the recess. (Fig. 86.)

If the depth of the recess is greater than the thickness of the pattern plate, part of the recess will be in the pattern itself. (Fig. 87.) This will always occur if the depth of the recess is greater than the thickness of the plate. When made in cast iron a usual thickness is $\frac{5}{8}$ in. for sizes up to about 2 ft. 0 in. × 1 ft. 6 in. Plates of this type having part of the pattern on either side are called "Turnover Plates."

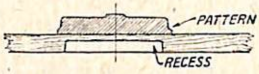


Fig. 85.—Pattern mounted on wood plate

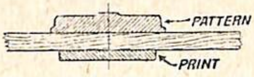


Fig. 86.—Print in place of recess when using core

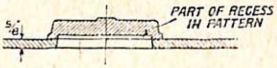


Fig. 87.—Recess cutting through plate and into pattern

A very satisfactory method of pattern mounting, and one that helps to eliminate the risk of error in locating two parts of a pattern which would normally be mounted on opposite sides of a plate, is illustrated by the following. Fig. 88 shows the section of a bearing cap and Fig. 89 the pattern to produce it. This is made with a flange having a spigot which fits into a corresponding hole in the plate. These spigot flanges are made to a standard size so that a variety of different patterns, each with its own flange, may be fitted to a single plate. The pattern shown would be turned up from a casting having an allowance for machining all over. It will be noticed in Fig. 89 that the small diameter hole at the top does not go right through the pattern, although when the two halves of the mould are assembled the sand "cuts through," so making a hole in the final casting, Fig. 90. The thickness of the metal "T" above the hole must be equal to the thickness of the pattern plate.

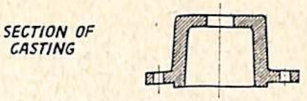


Fig. 88

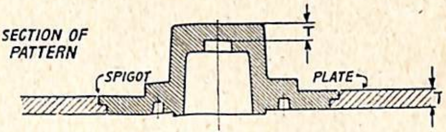


Fig. 89

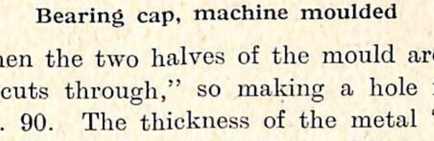


Fig. 90

Bearing cap, machine moulded

Reversible pattern plates

We now come to the important class of pattern plates commonly known as the "reversible type."

A casting that is symmetrical about a centre line can be made using only half a pattern. For example, a half tee piece may be fastened to the plate which has two holes to take the pins of a moulding box (Fig. 91.) After ramming this part, and removing it, pins are fitted into the holes on the plate, and the other half box (without pins) put in its place and also rammed up. These two halves when fitted together form a complete mould, the same half pattern having served for both the cope and the drag. The chief factor in this class of work is accuracy in locating the pattern in relation to the holes for the box pins.

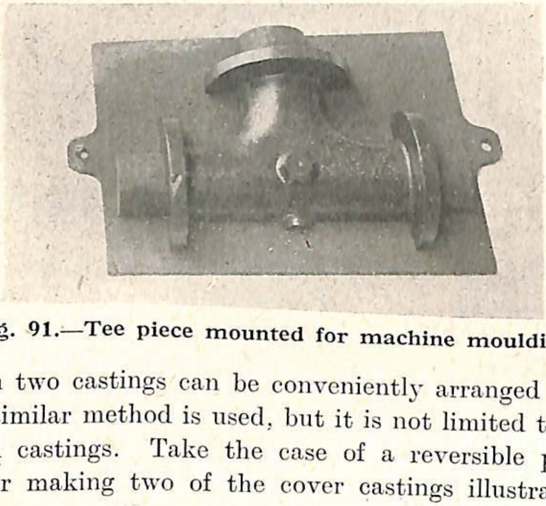


Fig. 91.—Tee piece mounted for machine moulding

When two castings can be conveniently arranged in one box, a similar method is used, but it is not limited to symmetrical castings. Take the case of a reversible pattern plate for making two of the cover castings illustrated in Fig. 92.

The plate carries one pattern only and one recess; both are on the same side (Fig. 92). The way in which they are spaced on the plate is clearly shown in the plan view. Reference to Fig. 93 will show how the two moulds appear in the rammed up boxes. This method is, of course, not suitable for making all types of castings and obviously can only be used when it does not matter which side of the casting is made uppermost. If the depth of the recess is greater than the normal thickness of the plate (as already mentioned) the plate may be cast with an extra thickness of metal to provide for the depth, as the underside of the plate is not used for the purpose of moulding. (Fig. 92.) Alternatively, if it is desired to use a flat plate, a loose ring and cover may be fitted and secured by setscrews to the underside to give the required depth D. (Fig. 94.)

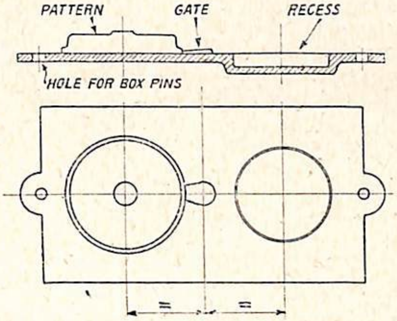


Fig. 92.—Reversible pattern plate

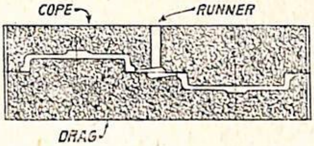


Fig. 93.—Mould for two castings made from reversible pattern plate

The same method is adopted for four castings in a box but in this case the plate has two patterns and two recesses arranged as shown in Fig. 95.

Fig. 96 shows the arrangement of a pattern to make two tee-section castings in a box by the same means.

Perhaps the name "reversible pattern plate" is a little misleading, for the plate itself is not reversed, only one side of it being used. It is really the mould which is reversed when assembling the cope on the drag.

Stripping plates

When it is necessary for a casting to be made without taper, such as a gear wheel with cast teeth (as alternative to machine cut teeth), a stripping plate is used to ensure a clean draw. This is simply a plate with a hole in it which is exactly the same profile as the pattern. The pattern itself is deeper, by the thickness of the stripping plate, than the final casting is required. When in use, the stripping plate is slipped over the pattern before ramming up the mould. After this has been done the pattern is withdrawn from the sand and through the plate, which remains on the joint of the mould, and by so doing prevents the parallel teeth of the pattern spoiling the mould through the sand adhering to them. When the pattern is removed the stripping plate is simply lifted off.

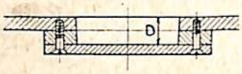


Fig. 94. — Alternative method of forming recess, using a flat plate

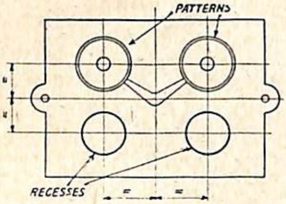


Fig. 95.—Arrangement of patterns for four castings in a box

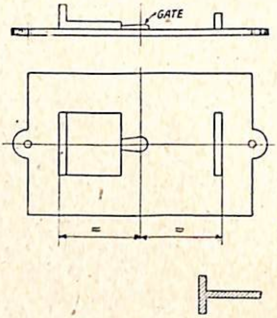


Fig. 96.—Reversible pattern plate for tee section castings

Fig. 97 shows a photograph of a small gear wheel pattern mounted for machine moulding, and the stripping plate used.

Intricate patterns

Work on moulding machines is not confined to comparatively simple patterns as described above ; quite intricate castings can be made almost as easily, once the pattern and plate or plates are prepared. Such patterns, however, involve considerable work, and large sums are spent in preparing them for mounting on the machines.

Various patterns for making a mould requiring a three part box are shown in Figs. 98-101. These also show the moulds and the different plates on which the pattern is mounted before each ramming operation. The main part of the pattern, or body, is shown in Fig. 98, which also shows the special plate to receive the body so that the drag will carry the sand forming the inside of the casting. This plate is really more in the nature of a frame. On the cross member will be noticed a projecting boss to form the centre recess in the "core." The drag is seen on the right hand side

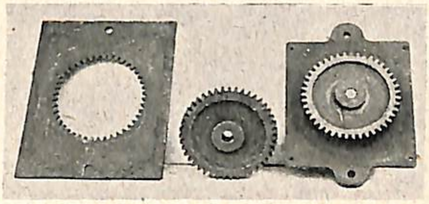


Fig. 97.—Pattern and stripping plate for gear wheel

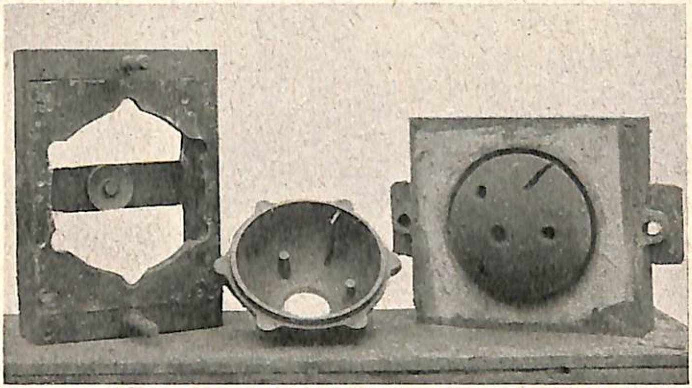


Fig. 98.—Casting, machine moulded. Drag and core rammed

after ramming up and removal from the pattern. Next comes the middle. After removing the pattern from the plate, shown in Fig. 98, it is fitted to another plate seen at the top of Fig. 99, and from this the middle part is made. Two views of this are given, the one taken from the top being on the left hand side. The loose piece of the pattern is clearly indicated, and this is lifted out first, leaving the impression of the four lugs and the prints for cores in the upper face of this portion of the mould before the box part is removed from the pattern. Notice the runner and gate, the latter being formed in the sand by a suitably shaped projection fitted to the plate. A further plate is used when ramming the top part (cope) which carries a projecting rim. The recess in the top of the casting is made by the sand rammed into the recess inside this rim (Fig. 100).

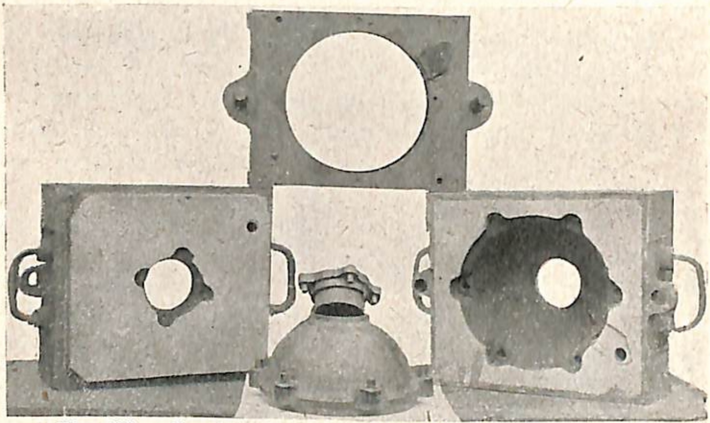


Fig. 99.—Casting, machine moulded. Middle part

Finally, the three separate parts are assembled. Fig. 101 shows their relative positions as they are put together, using large loose pins to ensure that each is in correct relation to the others. On the left, a casting made in this mould, and carrying the runner and riser, will be seen in its unfettled state.

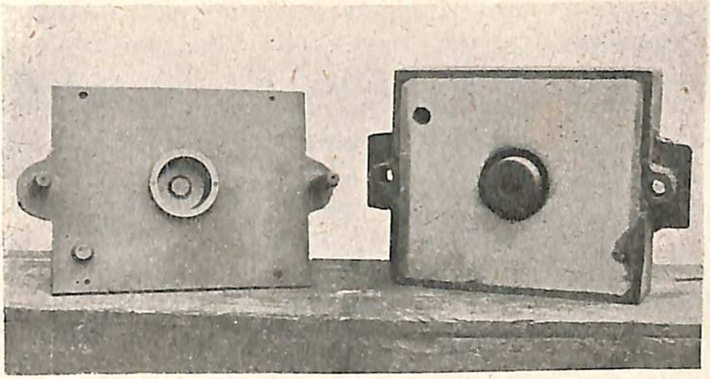


Fig. 100.—Casting, machine moulded. Top part

Strickles

To provide a full set of patterns for large jobs is a costly matter, but a widely used method of moulding circular or symmetrical castings by the use of strickles reduces pattern making to a minimum. A strickle is simply a piece of wood having its edge cut to the profile of the casting to be made. For a circular mould it would be attached to a central spindle and gradually moved round, the *sand* forming the

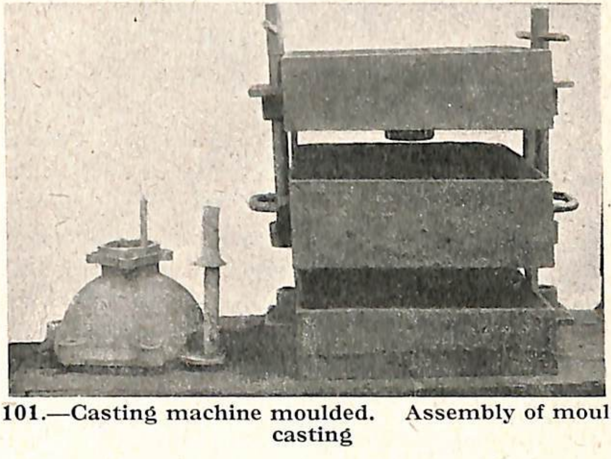


Fig. 101.—Casting machine moulded. Assembly of mould and casting

mould being built up or cut away to the path made by the edge of the board. This edge is bevelled off on one side to an angle of about 45 deg.—not to a feather edge, but so that a $\frac{1}{8}$ in. or 3/16 in. of flat is left. The direction of rotation is with the bevelled surface forward. It is, however, generally necessary to move the strickle to and fro several times before an even surface is obtained on the *sand*.

It will be noticed above that the word "sand" is in italics. Strickle moulds actually made of sand are not uncommon, but more frequently a material called loam is used for either the mould or the core or both. This material is much more plastic than ordinary moulding sand and its use calls for somewhat different methods than are used in sand moulding. (See "Loam moulding.")

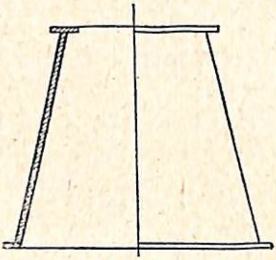


Fig. 102.—Cone casting

Fig. 102 shows a large conical casting having an internal and external flange at the top and an ordinary external flange at the base. Figs. 103 and 104 illustrate the method of fixing the strickles to a centre spindle which is free to revolve in the heavy footstep bearing. This shows how the outside of the mould is produced by the strickle with the required profile on its outer edge, and the core by another strickle attached to the same spindle having the profile of the core on its inside edge. Obviously, these strickles must be carefully set to ensure that when rotated they will leave a mould or core of the correct diameter.

When the strickle and arm are removed, the mould and core can be finished on their surfaces and dried in the drying stove. After this process, which may take as long

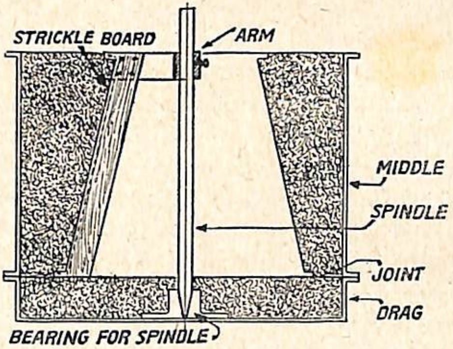


Fig. 103.—Strickling the middle

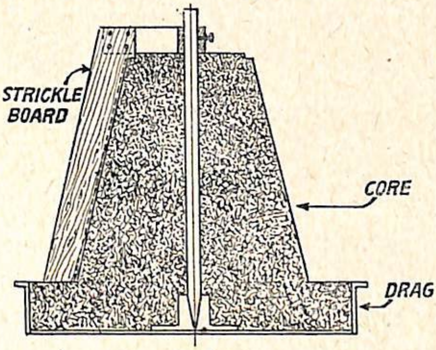


Fig. 104.—Strickling the core

Use of strickles in preparing mould and core

as two days for a large job, they are taken back to the foundry and assembled ready for casting.

Figures 103 and 104 are not intended to show the processes of moulding, but only the application of the strickles in preparing the mould. Box parts are, in fact, often dispensed with altogether in loam moulding.

Another extensive use of strickles is for turning up circular loam cores on a barrel. Fig. 105 shows the section of a cast column having a large base and a tapering stem. Obviously a core-box to make the core for this column, shown in Fig. 106, and perhaps 10 ft. 0 in. long, would be quite a costly thing to construct. A much cheaper way is to turn the core, particularly if only a small number are required ; indeed for many jobs it would be an altogether more satisfactory method.

The principle is much the same as that used for the conical casting just described, but this time the strickle,

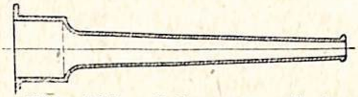


Fig. 105.—Column casting

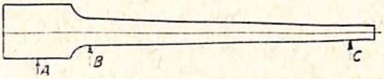


Fig. 106.—Turned core

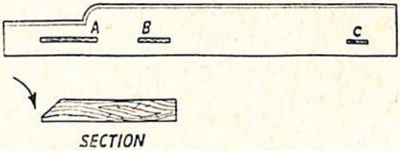


Fig. 107.—Striking board or loam board

sometimes called a striking board or a loam board when used in this way, is stationary and the core itself is revolved, being built up with loam to the required size. The board used is shown in Fig. 107. The three strips of wood, A, B and C, on its surface are provided by a thoughtful pattern maker so that the core maker can set his calipers by them when checking the diameter of the core at the points indicated. The striking board must be set at the correct distance from the axis of the core barrel or these diameters will be incorrect. The arrow indicates the direction in which the core is rotated in relation to the bevel on the edge of the board.

Loam patterns of circular section are made in the same way.

Finally, the pattern shop has to make a variety of other articles which the moulder is constantly requiring to assist him in the foundry. Turning over boards; shaped pieces of wood for "mending up" a mould that has become damaged—perhaps through carelessness in withdrawing the pattern; thickness gauges, sometimes required when setting a core to ensure an even thickness of metal throughout; lengths of timber for checking the diameter or other dimension of a mould, sometimes called "staffs," wedges and the like—all these are the responsibility of the pattern shop.

Generally, the pattern shop is responsible for the care of its products, certainly for maintaining them in good condition. Patterns are best stored in racks in a cool, dry building until they are again required in the foundry. It is customary for each pattern as it is made to be given a reference number which is stamped on the pattern itself and recorded, together with a brief description and the date, etc., in a card index.

GLOSSARY

Batten. Strip of wood for fastening two or more boards together: also used to strengthen a fragile pattern, the impression which it leaves in the mould being " stopped off " by the moulder.

Boxing up. Construction of a pattern or core box from separate pieces of timber as opposed to making from a single piece of wood.

Body. Main portion of a pattern.

Camber. Distortion on castings of certain sections as they cool. Sometimes corrected by opposite or negative camber on pattern.

Contraction. Shrinkage due to cooling of the metal of which the casting is composed. Allowance for this contraction must be made by the pattern maker.

Contraction rule. A rule, specially graduated to give a direct reading, which includes the necessary allowance for contraction

Core. That part of a mould which forms the inside of a casting.

Core print. Projection on a pattern which forms a recess in the mould into which the core is placed to locate and support it.

Chill. Metal piece forming part of the mould with which the fluid metal comes into contact when casting.

Cope. Upper part of a mould

Core box. Specially shaped box or frame in which the sand core is made.

Core board. Board used for strickling which has the profile of the core to be produced.

D prints. (See tail prints.)

Dowels. Used to locate two or more parts of a pattern which are made separate to assist the process of moulding.

Drag. Lower part of a mould.

Draw. Act of removing a pattern from the mould. (Also used to denote a certain defect in a casting.)

Drop print. (See tail prints.)

Face. Used to denote the surface of a pattern or casting. Thus: " the face of a flange."

Face plate. Circular plate mounted on a lathe mandrel to which the work is attached.

Fillet. Strip of wood or other material fitted to a pattern where two surfaces intersect to form a radius at the junction.

Gate. Passage admitting molten metal to a mould.

Head. (Header.) Excess of metal on the upper part of a casting to ensure soundness of the remainder. Usually provided for on the pattern.

Joint. Junction of two parts of a pattern. Also used to describe the division of two or more parts of a mould.

Lag. (" Lagging up ".) To form a pattern by a series of strips. To increase the size of an existing pattern by means of thin strips or by attaching cardboard, etc., to it.

Lift. (See draw.)

Loam board. Similar to a core board but applicable also to a board for making the mould.

Loam pattern. Temporary pattern prepared by the moulder or core maker to strickles provided by the pattern shop.

Master pattern. Preliminary pattern, generally made of wood, from which a cast metal pattern is made. Master patterns are given extra allowance for contraction to allow for the shrinkage of the metal pattern *and* of the casting itself.

Mending up strip. Piece of wood shaped to suit a certain part of a mould that may have become damaged, by a faulty draw or other reason, to assist the moulder in restoring the correct shape.

Mould. Term used to describe any impression in sand or other material into which metal is poured.

Moulding box. Frame which retains the sand of which a mould is made.

Pattern. Model which serves as an original from which castings are made. Generally constructed of wood.

Plate patterns. Patterns arranged for mounting on flat plates. Usually reproduced by means of moulding machines.

Pocket print. (See tail print.)

Print. (See core print.)

Quick. Term used to describe a small radius.

Rapping. Loosening of a pattern before withdrawing it from the mould.

Rapping plates. Metal plates attached to a pattern having a hole to receive a pointed bar which is knocked back and forth to loosen the pattern before withdrawing it from the mould.

Setting out. Preliminary marking out of work before commencing to make a pattern.

Staff. Wood strip of an exact length used to check a dimension of a mould or of a core.

Stop off. Alteration in the length or other shape of a mould by the moulder, to avoid altering or spoiling an existing pattern which is sufficiently correct for the purpose without a major alteration by the pattern shop.

Stopping off piece. Piece of wood provided to assist the moulder in stopping off.

Strickle. Board having the profile of the mould or core required.

Striking board. Similar to a strickle or a core board. The name may be applied to either.

Sweep. Board having a definite outline used to produce a mould or core. (The terms: core board, striking board, strickle, loam board, sweep, are more or less synonymous.)

Stripping plate. Plate, generally used in machine moulding, through which the pattern is withdrawn to prevent damage to the mould, particularly if the pattern has no taper.

Taper. Slight slope given to a pattern to assist in its easy removal from the sand.

Thickness strips. Wood strips of determined thickness to check the location of a core in a mould to ensure equal thickness throughout where necessary.

Tail print. Special core print which permits a core to be located in the mould below the joint. After the core is in position the space occupied by the print is filled with sand or "stopped off."

Turning over board. Board or plate used to support the pattern while ramming up the mould. Sometimes provided with recesses or projections to accommodate the shape of the pattern on that side not being rammed up.

Template (Templet). Piece of wood or other material having a definite profile which is used as a jig or gauge to ensure correct shape of the mould or pattern being made.

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